ENGLISH

ORTHOPANTOMOGRAPH® OP300

Digital Panoramic X-Ray System

Service Manual

204904 rev. 3

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1 Introduction

1.1 ORTHOPANTOMOGRAPH® OP300

INSTRUMENTARIUM DENTAL®
ORTHOPANTOMOGRAPH® OP300x-ray unit (hereafter called “OP300”) is a software controlled diagnostic dental X-ray equipment for producing high quality digital images of dentition, TM-joints and skull. In order to take images with OP300 you need a suitable PC hardware connected to the OP300 unit and CLINIVIEW™ software (or suitable third party software via TWAIN driver) to capture and handle images.

OP300 performs the following procedures:

Pan

- Standard panoramic
- Pediatric panoramic
- Wide arch panoramic
- Bitewing
- TMJ, PA projection
- Ortho TMJ, axial corrected lateral projection
- Maxillary sinus
- Ortho Zone enhanced panoramic
- Orthogonal panoramic

Ceph (optional)

- Cephalo lateral projection
- Cephalo pediatric lateral projection
- Cephalo postero-anterior (PA) projection
- Reverse Towne projection
- Waters view
- Carpus view (Not in USA and Canada)

3D (optional)

- 61x41 mm Field of View
- 61x78 mm Field of View

1.2 References

The following instructions are delivered with the OP300 installation manual:

- Firmware update instructions
- Calibration instructions
- Cephalostat upgrade instructions
- Cephalostat side changing instructions

The following instructions are separate and can be ordered from customer service:

- 3D upgrade instructions are delivered with the 3D upgrade kit
- Graphical user interface side changing instructions are delivered separately when ordered

1.3 Intended use

OP300 must only be used and operated by dentist and other qualified professionals. OP300 must only be used to take panoramic, cephalometric and 3D images of the dento-maxillofacial complex of the human skull. It must not be used to take images of any other part of the human body.

Panoramic and 3D exposures should not be used if conventional intraoral radiographic images (bitewing exposures) would be sufficient.

Cone beam computed tomography images are not adequate for the analysis of soft tissue.

CAUTION! *USA only: Federal law restricts this device to sale by or on the order of a dentist or other qualified professional.*

1.4 Associated documentation

- OP300 user manual
- OP300 installation manual
- The CLINIVIEW™ software user manual
- The CLINIVIEW™ software installation manual
- The user manual supplied with the dental imaging software
- The installation manual supplied with the dental imaging software
- The user manual supplied with the 3D imaging software
- The installation manual supplied with the 3D imaging software

1.5 Abbreviations used in this manual

FOV = Field Of View. The cylindrical 3D volume that is reconstructed by the system.

ROI = Region Of Interest. The anatomical area or region of the patient that you are interested to examine.

FH = Frankfort-Horizontal

H = Horizontal

1.6 Warnings and precautions

To be observed during service

Before attempting to service the device make sure that you know how to operate it. Read the user's manual.

Read and familiarize yourself with the warnings and precautions listed in the user's manual.

Only use original spare parts from the manufacturer when repairing the device or replacing parts.

Warning - Radiation Safety

Before servicing the unit familiarize yourself with local and national radiation safety standards and requirements relating to dental x-ray equipment.

Warning - Mechanical safety

Disconnect the unit from the main power supply before removing any covers.

Disconnect the unit from the main power supply before repairing or replacing mechanical parts or installing accessories.

Be careful when operating the unit not to get body parts or clothing trapped between moving parts.

Warning - Electrical Safety

Disconnect the unit from the mains power connection before servicing the unit, e.g. replacing circuit boards or other electrical components.

If there are capacitors on a circuit board or electrical device wait ten (10) minutes, after disconnecting the unit from the power supply, before handling the board or device.

If you have to leave the unit unattended with covers removed during servicing or maintenance, disconnect the unit from main power supply so that anyone who inadvertantly touches the unit does not receive an electric shock.

This unit should only be used in areas that are provided with a protective earth connection to ensure an equipotential ground connection.

Caution - Electrostatic discharge

Electrostatic Discharge (ESD) can damage or destroy electronic components.

When servicing the device take precautions to avoid electrostatic build up and discharge (ESD). Follow the recommendations for the prevention of ESD that are used in the country in which you are working. If no recommendations are available follow the guide lines below.

Leave all new or replacement circuit boards and electrical parts in their protective packaging until the boards are needed.

Before handling circuit boards and electrical parts make sure that any static electricity charge that has built up in you body is discharged.

When handling circuit boards hold them by their edges and do not touch any connectors or components.

When examining and checking circuit boards use an elasticated wrist wrap which is connected to a ground point through a 1 Mohm current limiting cable. For a ground point use water pipes, radiators or other objects that are known to be connected to the ground. Also use a cable to connect the x-ray unit to the same ground potential as the wrist wrap.

If an antistatic mat is used, connect the wrist wrap to the mat and the mat to the ground potential.

Wash the wrist wrap and check that it is in good condition frequently.

Warning - Explosion hazard

Some disinfectants and cleaning agents may vaporize to form an explosive vapour. If such disinfectants and cleaning agents are used the vapour should be allowed to disperse before switching the unit on.

Warning - Cleaning the unit

Switch the unit off and disconnect it from the main power supply before cleaning or disinfecting the unit.

To be observed during use

Always use available disposable protective covers with the patient positioning accessories:
Bite fork cover
Chin support cover
Head support cover
Nose support cover
Ear holder cover

Correct sharp layer should be chosen when using multilayer PAN images. See user manual chapter Multilayer PAN images for correct procedure.

Warnings to be observed during installation and service

Only personnel trained and approved by the manufacturer of the unit are allowed to service the unit.

The unit must be installed and serviced according to the unit Installation & adjustments manual by a qualified technician.

The installer must ensure that:

- The fixing screws are suitable for the wall material.
- The wall for fixing the unit is strong enough for attaching the unit. It must withstand loads of 5000N or more.
- Pull out strength of the screws is 5000N or more.
- The wall fixing screws are adequately tightened.

To avoid the unit from tipping over, fix the unit with floor bolts appropriate to the surface the unit is mounted on. The bolts and the floor material must endure force of 5000 N.

The installer must ensure that the upper shelf attachment screws are tightened.

The unit should be installed in a place with enough space for safe operation. See the unit installation manual for recommended minimum site dimensions. It is the responsibility of the customer to ensure that the site is large enough for the patients.

Be aware of hot surfaces when removing covers during installation and maintenance.

When installing a dental X-ray unit always observe local and national safety, radiation control and electrical regulations.

General warnings

Panoramic and 3D should not be used for routine or screening examinations in which a radiograph is taken regardless of the presence or absence of clinical signs and symptoms. 3D imaging examinations must be justified for each patient to demonstrate that the benefits outweigh the risks.

Where it is likely that evaluation of soft tissues will be required as part of the patient’s radiological assessment,

the imaging should be done using conventional medical CT or MR, rather than 3D imaging using Cone Beam technology.

Make sure that patient's thyroid glands are protected by a lead apron during the exposure.

Excessive dust should be cleaned from the unit for free airflow and cooling. Switch of the unit before cleaning.

Always follow the instructions for patient positioning and imaging procedures instructed in the User Manual.

The place where the unit is to be installed and the position from where the user will take exposures must be correctly shielded from the radiation that is generated when the unit is operated. Ensure to fulfill or exceed the requirements of your local regulations.

The unit or its parts must not be changed or modified in any way without approval and instructions from the manufacturer.

When servicing use only approved replacement parts supplied by the manufacturer.

The use of accessories not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system.

If this device is used with 3rd party imaging application software not supplied by the manufacturer, the 3rd party imaging application software must comply with all local laws on patient information software. This includes the Medical Device Directive 93/42/EEC and/or relevant legal requirements in the USA.

Do not connect any equipment to the unit that has not been supplied with the unit or that is not recommended by the manufacturer. The use of accessory equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system.

The unit contains toxic materials that need to be handled properly when disposing the unit. Return the unit to the dealer in the end of its life cycle.

The aperture plate and the tube housing are made of lead (Pb), which is a toxic material. Do not touch it with your bare hands.

1.7 Unauthorized Modifications

Unauthorized changes or modifications to any part of the unit or its equipment can have hazardous consequences. Changes or modifications must not be made unless specifically authorized by the manufacturer. When properly assembled with a compatible beam limiting device, the diagnostic source assembly will fully meet the United States of America Federal Performance Standards for Diagnostic X-Ray Systems and Their Components (21 CFR 1020. 30-32) provided. No parts may be removed from the unit and no unauthorized adjustments are made to the beam limiting device or tube housing assembly.

Never remove or remanufacture any part of the tubehead assembly or beam limiting device. Never adjust any part of the beam limiting device unless under the direction of the manufacturer or their authorized distributor.

1.8 Disclaimer

The manufacturer shall have no liability for consequential damages, personal injury, loss, damage or expense directly or indirectly arising from the use of its products. No agent, distributor or other party is authorized to make any warranty or other liability on behalf of the manufacturer with respect to its products.

1.9 Disposal

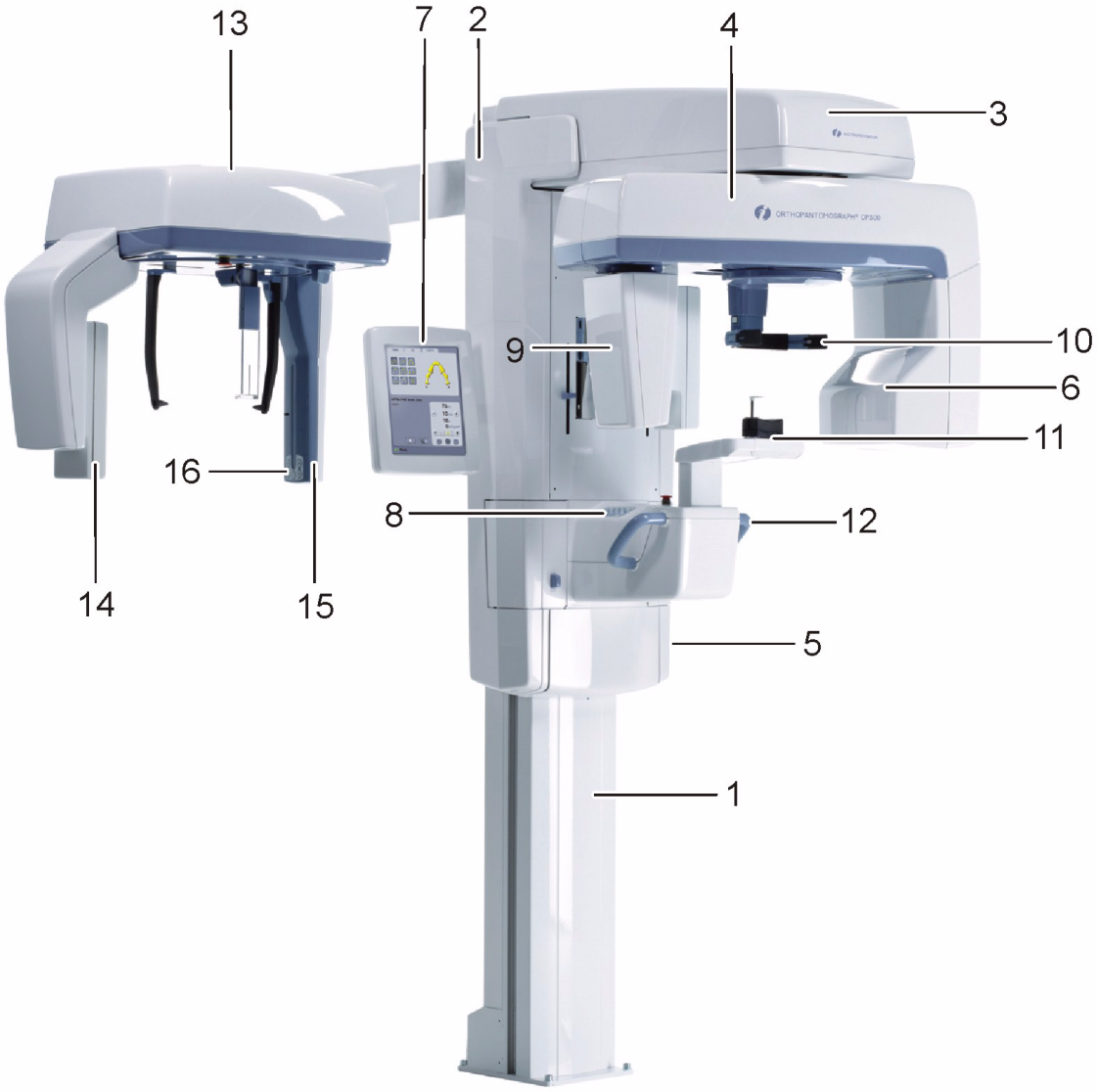
The device, its spare parts, its replacement parts and its accessories may include parts that are made of or include materials that are non-environmentally friendly or hazardous. These parts must be disposed of in accordance with all local, national and international regulations regarding the disposal of non-environmentally friendly or hazardous materials.

Unit has at least the following parts that should be regarded as nonenvironmental friendly waste products:

- Tubehead (Pb, oil)
- Collimator (Pb)
- All electronic circuits
- Sensor covers (EMC painted)

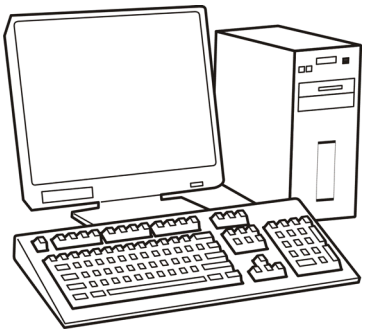
2 Unit description

2.1 Main parts and controls



1. Column
2. Carriage
3. Main support
4. Rotating unit
5. On / off switch (rear of carriage) and main fuses
6. Tubehead assembly
7. Touch screen display
8. Positioning panel
9. Sensor head
10. Head support
11. Chin rest
12. Handles
13. Ceph unit
14. Ceph sensor
15. Secondary collimator
16. Positioning panel

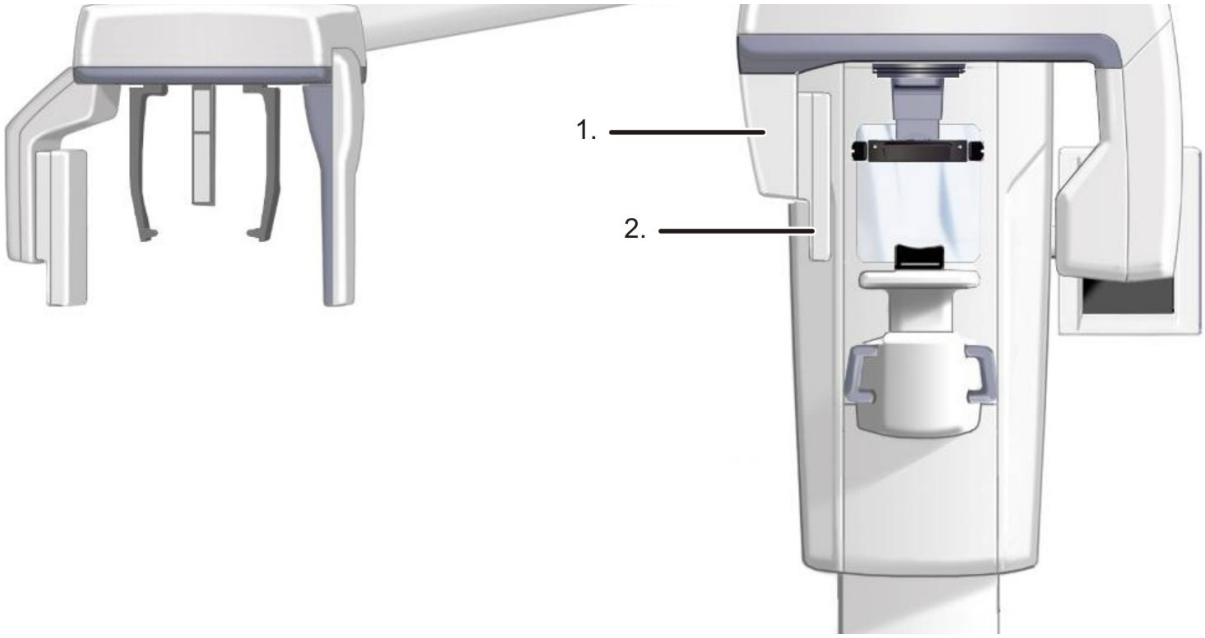
On/off switch and main fuses



PC with MDD approved dental imaging software and 3D viewing software.

All software must conform to the MDD and the relevant legal requirements in the USA.

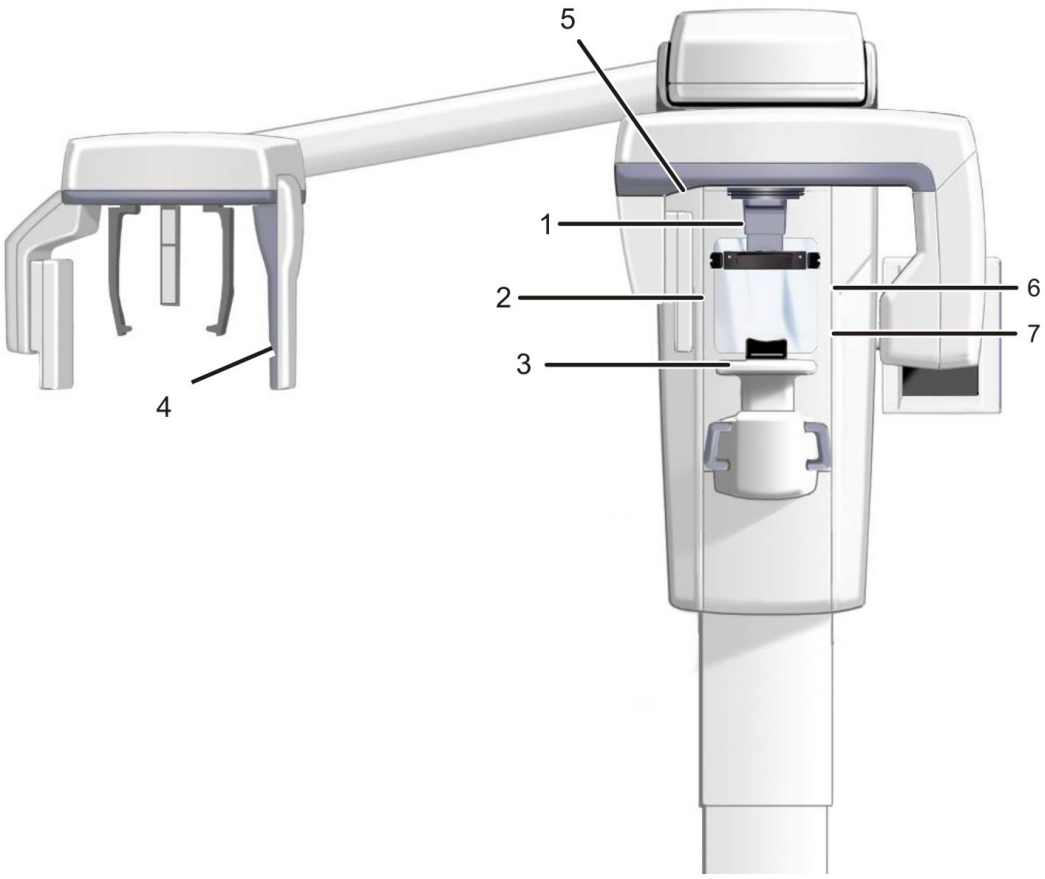
The PC must conform to all the unit and dental imaging software requirements.



1. Sensor holder (units without 3D option)
2. Panoramic sensor

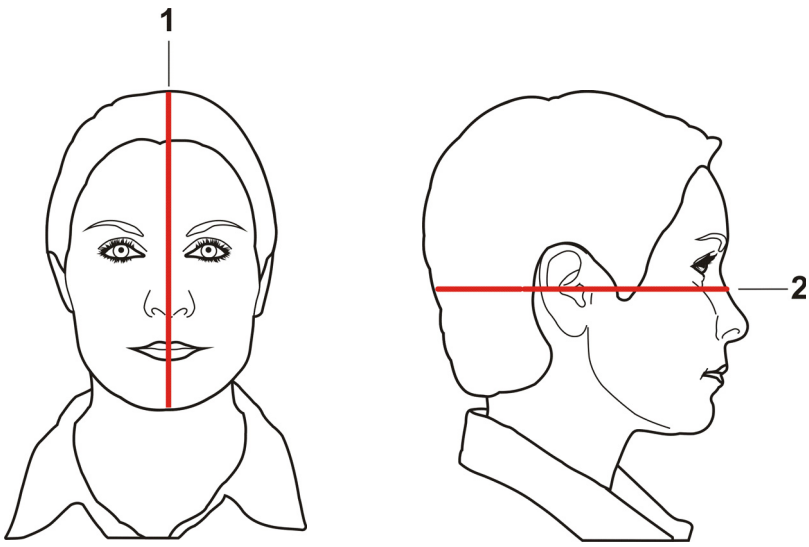
1. 3D sensor (units with 3D option)
2. Panoramic sensor

2.2 Patient positioning lights

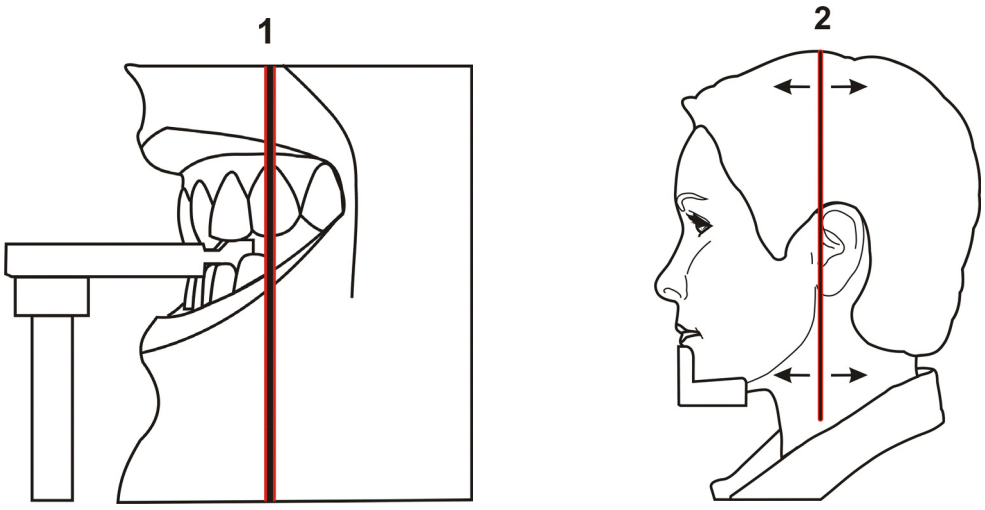


1. Midsagittal light
2. Frankfort horizontal (FH) light
3. Image layer light
4. Cephalometric FH light
5. TMJ light
6. Horizontal light, top of FOV (3D option only)
7. Horizontal light, bottom of FOV (3D option only)

Panoramic lights

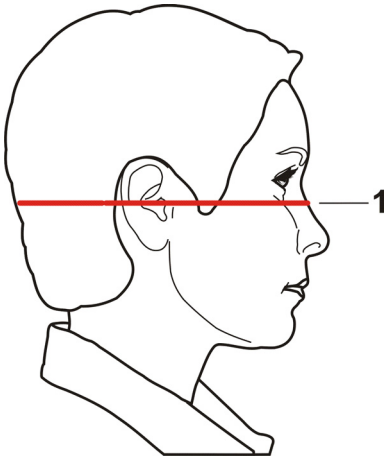


1. Midsagittal light
2. FH light



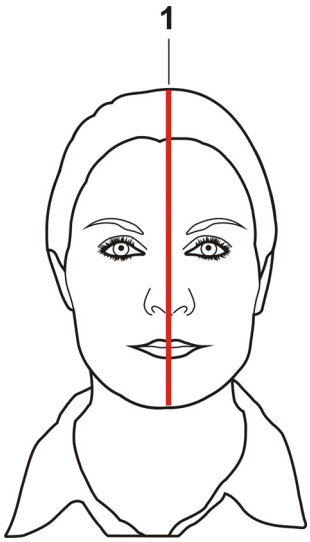
1. Image layer light
2. TMJ light

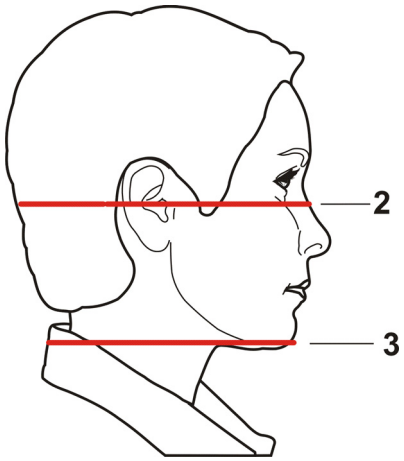
Cephalometric lights



1. FH light

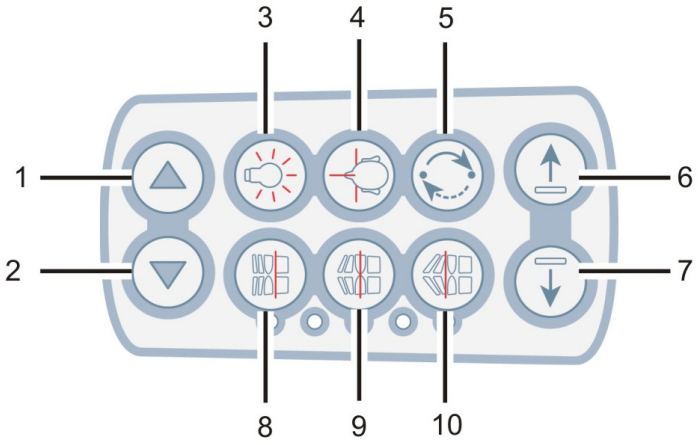
3D lights





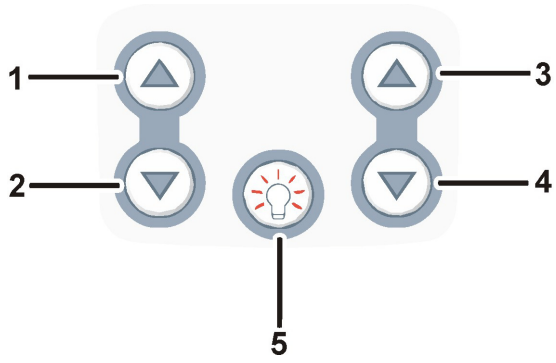
1. Midsagittal light
2. Horizontal light, top of FOV
3. Horizontal light, bottom of FOV

2.3 Patient positioning panel



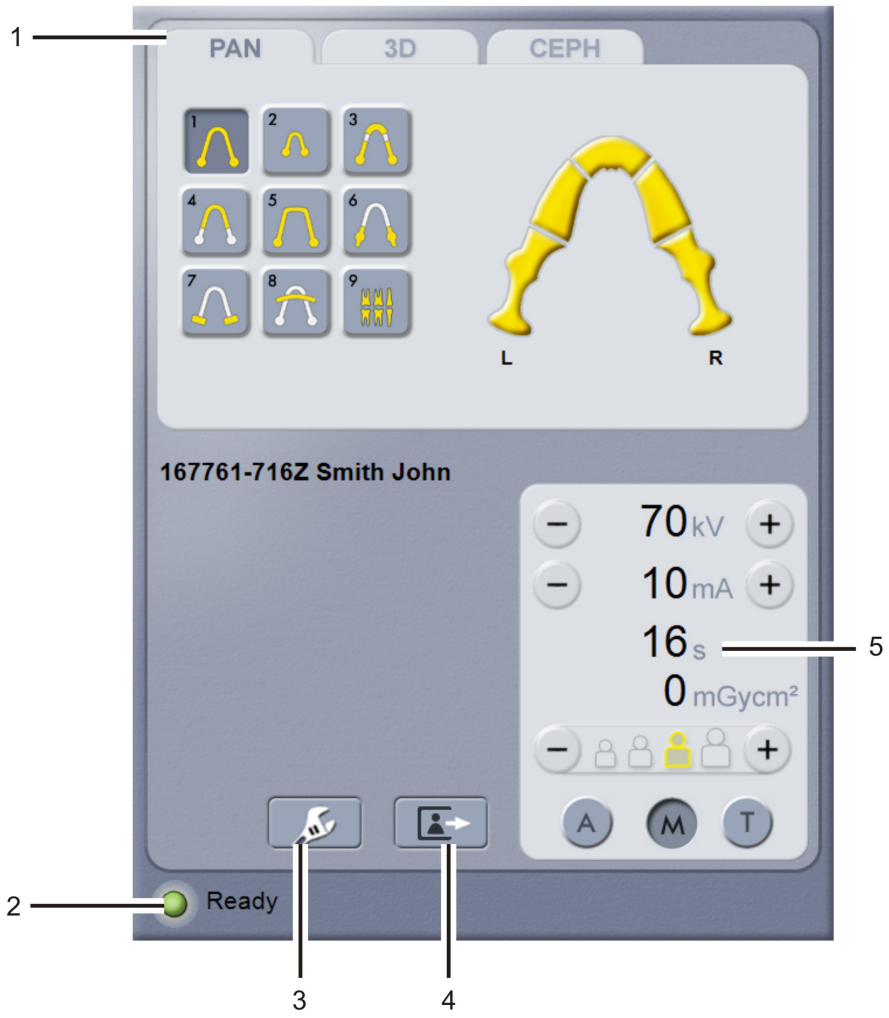
1. Carriage UP
2. Carriage DOWN
3. Positioning lights ON/OFF
4. Patient positioning
5. Start positioning
6. Chin support UP
7. Chin support DOWN
8. Move the image layer anterior before exposure 3 mm, with sinus program 10 mm
9. Normal occlusion/ reset position
10. Move the image layer posterior before exposure 3 mm, with sinus program 10 mm

Cephalometric unit



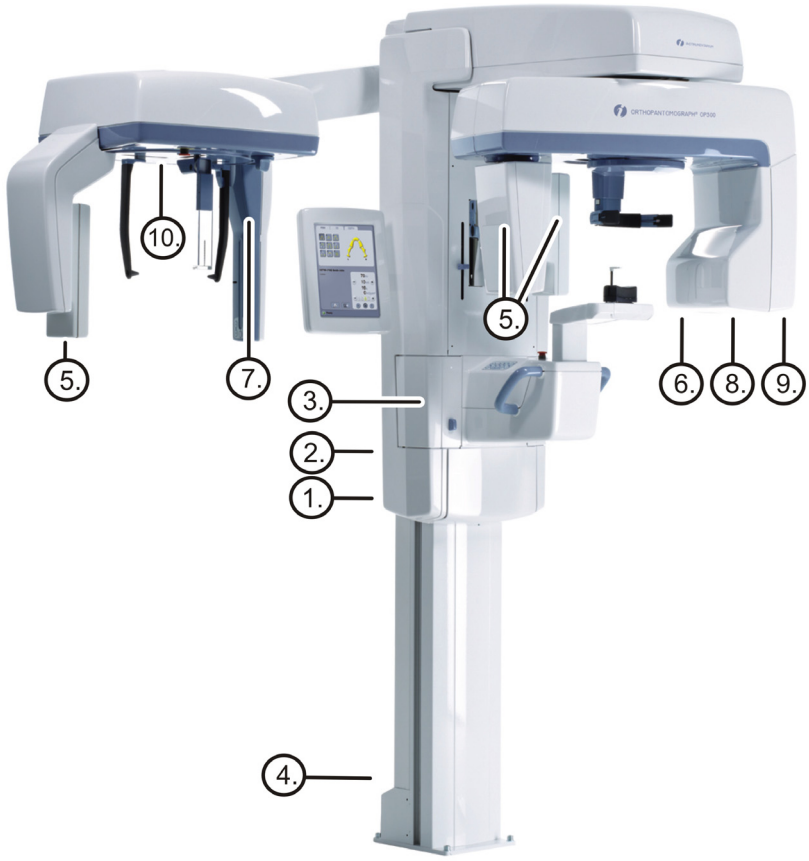
1. Carriage up
2. Carriage down
3. Carriage up
4. Carriage down
5. Positioning lights ON/OFF

2.4 Main control panel



1. Modality / imaging program section
2. Status of the unit
3. Settings
4. End examination
5. Exposure settings

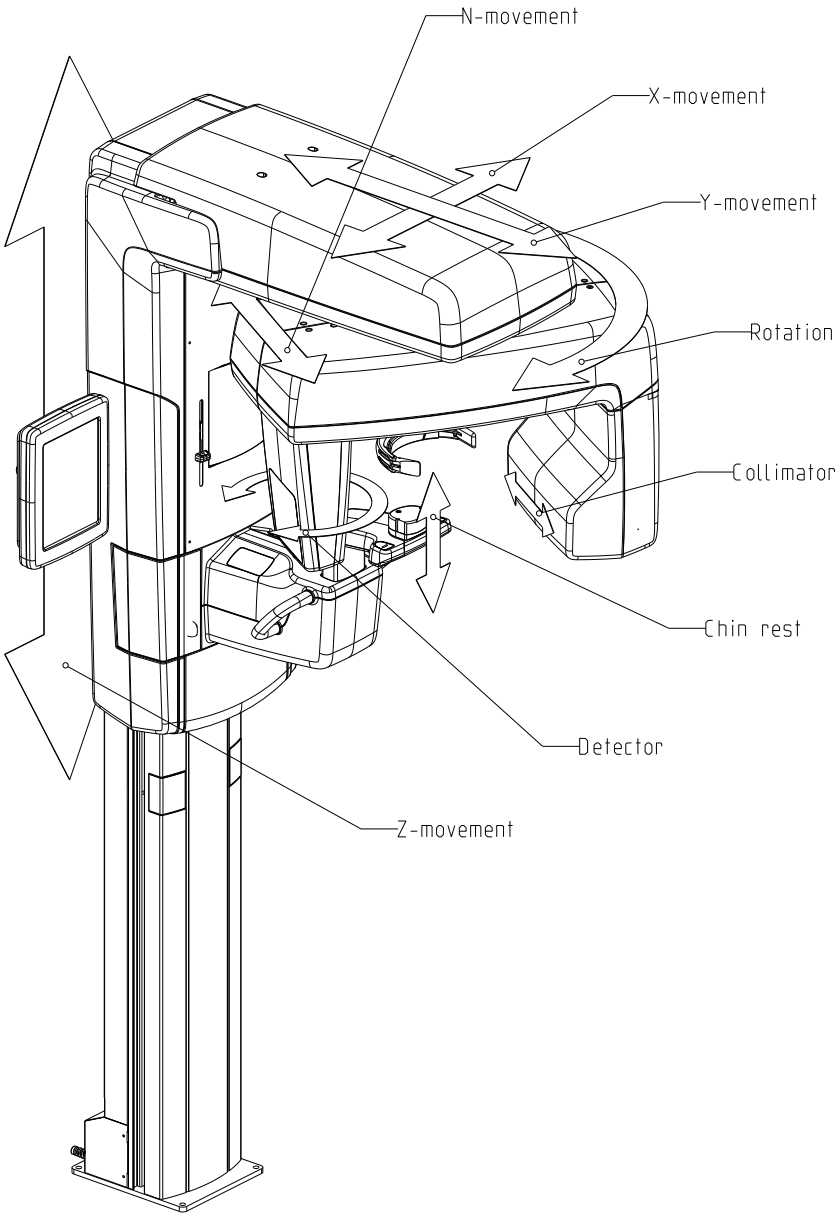
2.5 Unit identification labels



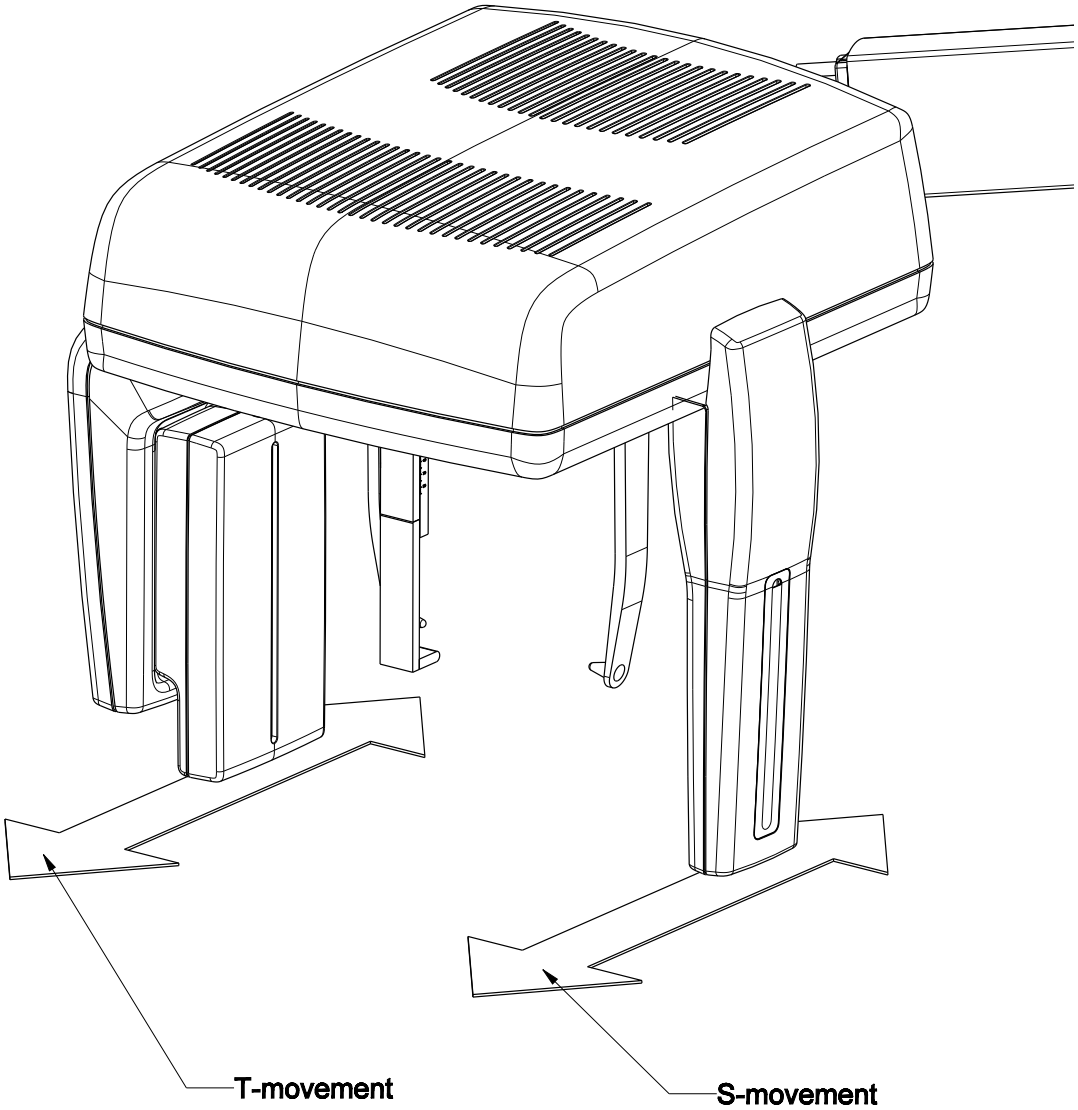
1. Main label
2. 10A & 15A Fuse labels (next to the fuse holder)
3. Laser class 1 warning label IEC 60825-1:2007
4. Ethernet label
5. Sensors
6. (Primary) collimator label
7. (Secondary) ceph collimator label
8. Tubehead label
   (on the tubehead and on the tubehead cover)
9. Warning label for deadly voltages
   (inside the tubehead cover)
10. Ceph main label

2.6 Unit movements

Panoramic unit movements



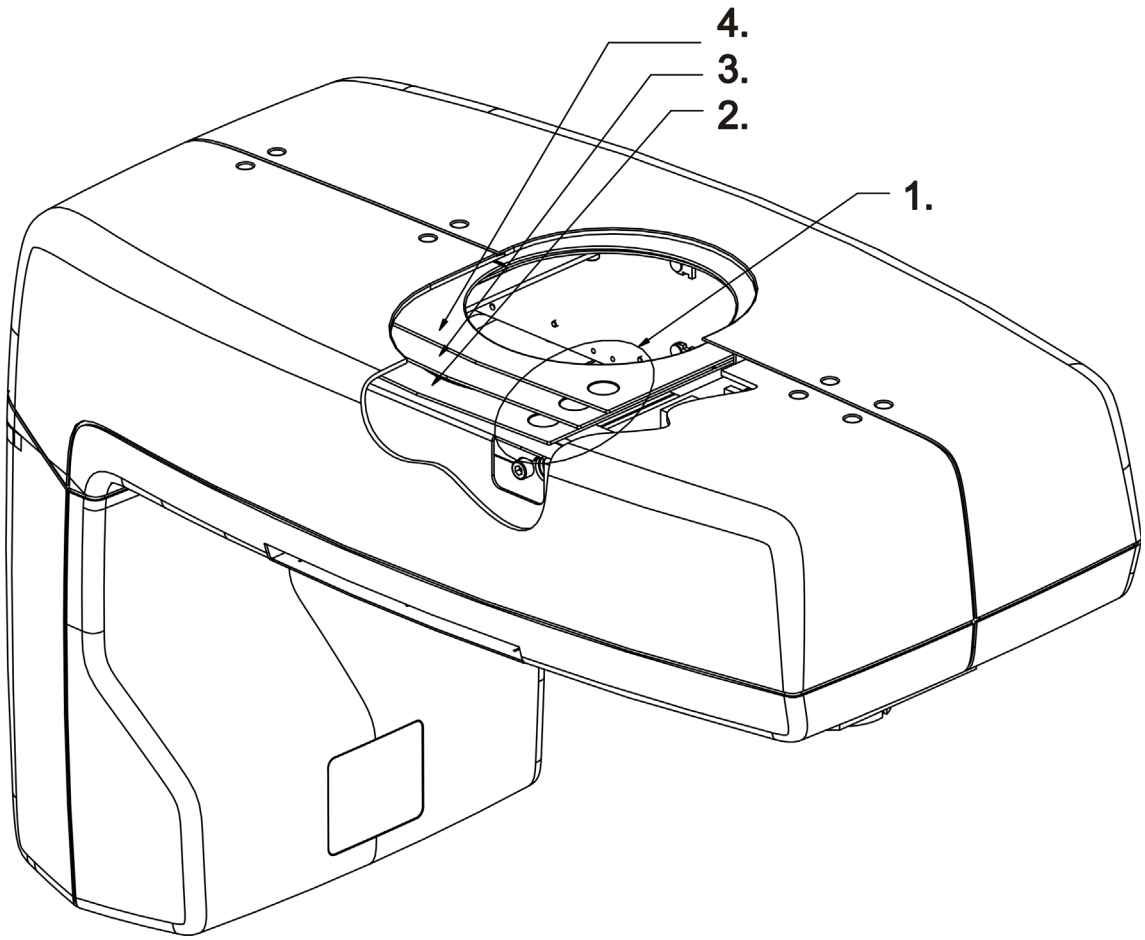
Cephalometric unit movements



2.7 Finger guards

If finger guards are installed incorrectly during the service, unit may get stuck in some extreme positions in N-movements.

Correct installing of finger guards:

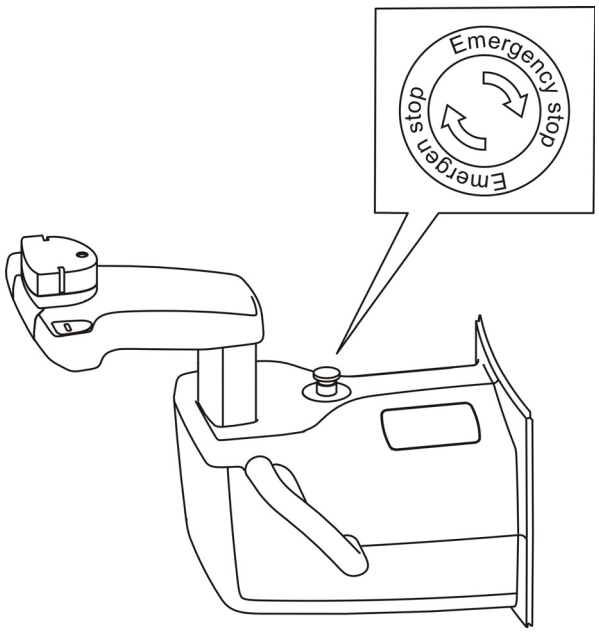


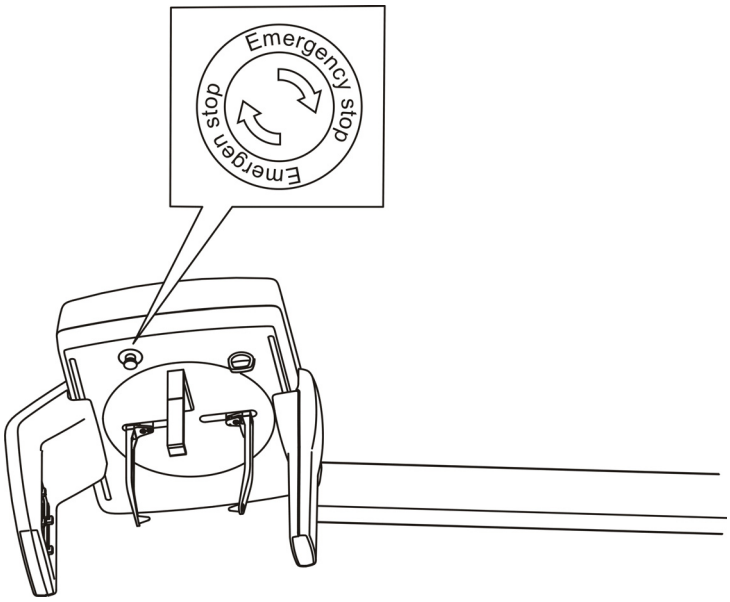
1. These marks should be in this corner facing up.
2. part number 204373 / SP00374
3. part number 204374 / SP00374
4. part number 204375 / SP00374

2.8 Emergency stop switch

In case of malfunction of the exposure button or other protective devices of the unit, an emergency stop switch is provided near the handles and on the roof of the cephalostat head so that the patient can reach it.

If the emergency stop switch is pressed during an exposure, the exposure is terminated immediately and the x-ray unit is completely stopped. An interrupted exposure cannot be continued later, but has to be retaken from the beginning.





Press to stop the unit, rotate to release.

3 Electrical description

3.1 Circuit boards

There are three types of circuit board. Some versions may have different and/or additional boards.

Logic boards

Three logic boards:

R3210	CPU (Additional one in ceph)
R3300	IO1
R3400	IO2

They all use FPGA chips and the embedded SW.
- One touch screen display PC board. It communicates via the internal Ethernet.

Power boards

Three low voltage boards:

EG400	Panel power supply
R5300	Panel raw power supply (Additional one in ceph)

Power supply for DC voltages (MPQ200D)

Two high voltage boards:

R3700	X-ray power supply
R3800	X-ray generator

Satellite boards

Seven (nine in cephalostat models) optosensor boards:

EB100	Rotator opto
6 x EG100	Dual opto board
2 x EE100	Ceph encoder opto board

Five (seven in cephalostat models) connector boards:

EA100	DC Power distribution board
EA200	AC Power distribution board
EA300	Connector board
EC100/ ED100	Panorama sensor connector boards
EE200/ ED200	Cephalostat sensor connector boards

Seven stepper drive modules
(two more with cephalostat option):

R5100	3-phase stepper drivers

Interface board:

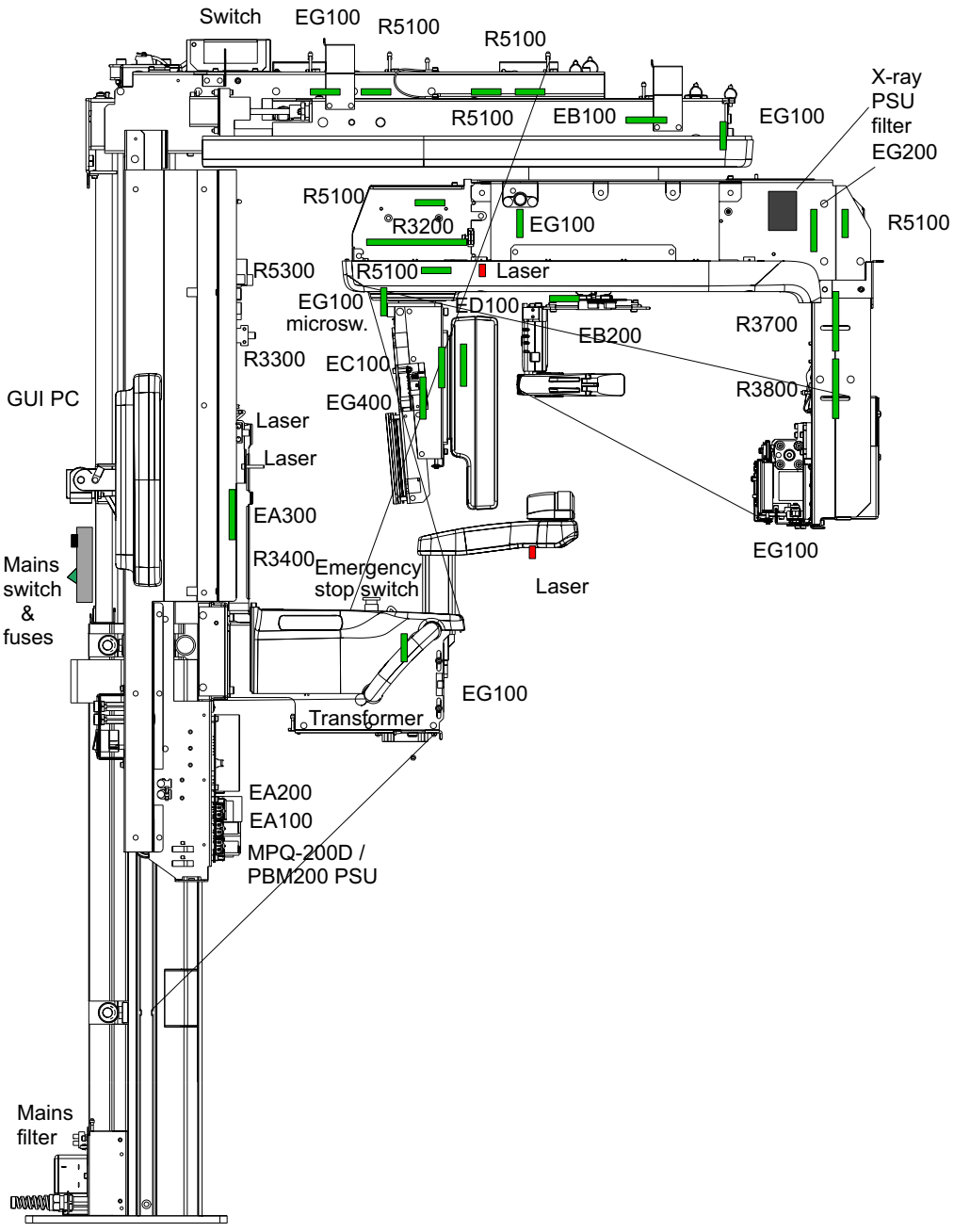
EG200	Interface board (Additional one in ceph)

Special purpose board

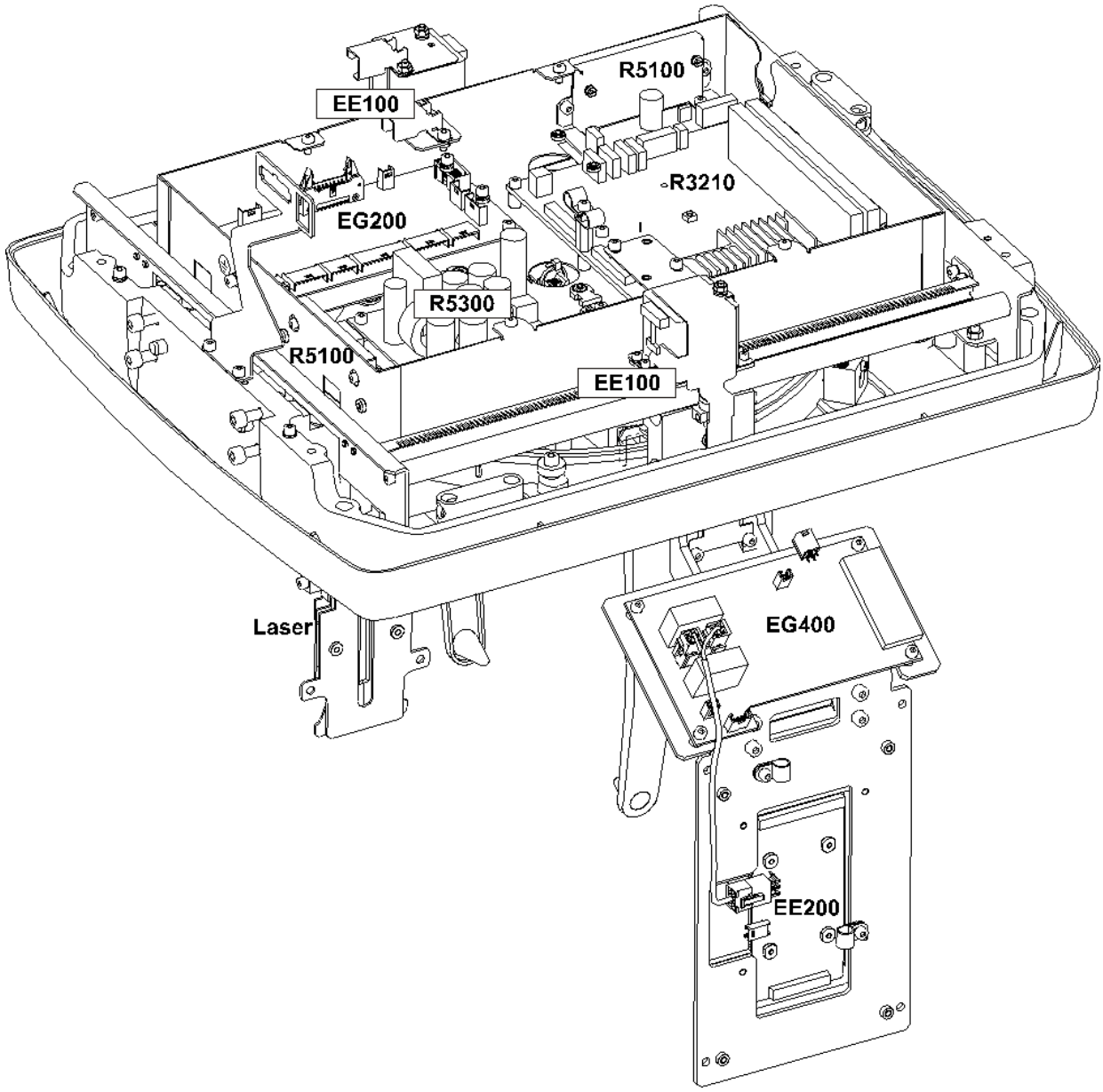
EB200	Head support board

3.2 Electrical component location

Circuit boards - Main unit



Circuit boards - Cephalometric unit



3.3 List of circuit boards and electric devices

Column

Mains filter

Warning light connector

Exposure switch

Ethernet Switch

Carriage

Touch screen display and PC

MPQ200D	Power supply
EA100	Power distribution board
EA200	Connector board
R5300	Panel raw power supply
R3300	IO1
R3400	IO2 + EA300 Connector board

FH-laser

FOV top laser / FOV bottom laser

Lower shelf

Chin support motor

EG100	Dual opto board

Emergency switch

Layer laser

Main support

R5100	3-phase stepper driver
X-motor	(3-phase stepper)

Main support

Y-motor	(3-phase stepper)
Rotation motor	(3-phase stepper)
2 x EG100	Dual opto board
EB100	Rotator opto board
EB200	Head support board

Rotating unit (top part)

EG200	Interface board
2 x R5100	3-phase stepper driver
N-movement motor	
EG100	Dual opto board
TMJ-laser	

Rotating unit (tubehead assembly)

R3700	X-ray power supply
R3800	X-ray generator
X-ray tube	
Generator filter	
two generator fans	
C-motor	(Collimator)
EG100	Dual opto board

Rotating unit (sensor head)

R3210	CPU
R5100	3-phase stepper driver sensor swapping motor
EG100	Dual opto board
EG400	Panel power supply
3D-sensor	(CMOS)
EC100	Panoramic connector board

Cephalostat main assembly

R3210	Ceph CPU
EG200	Interface board
R5300	Panel raw power supply
R5100	3-phase stepper driver

Cephalostat (Secondary collimator)

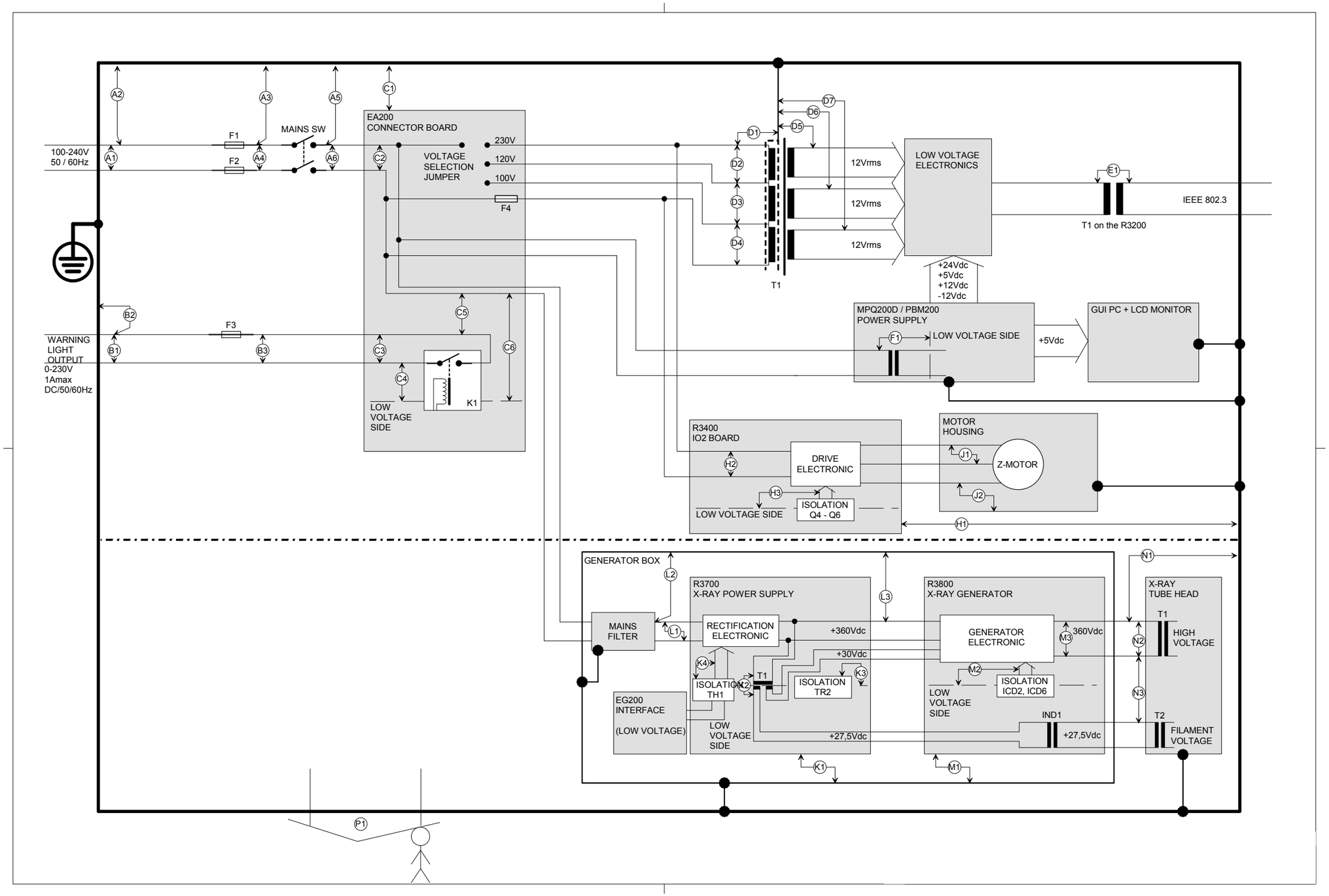
EE100	Ceph encoder opto board
S Motor	(secondary collimator)
FH laser	
Up/down/lights panel	

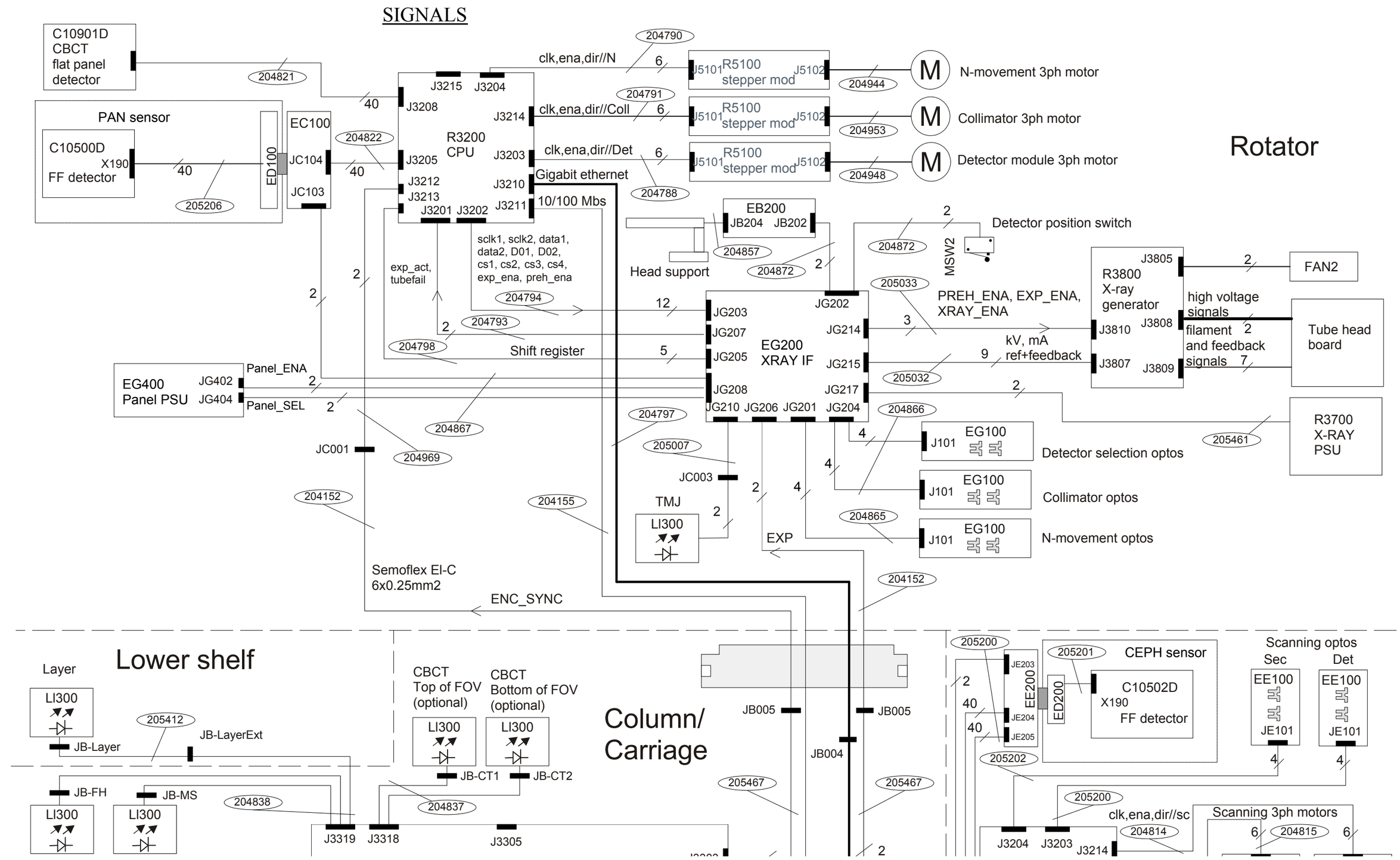
Cephalostat (sensor head)

EG400	Panel power supply
EE100	Ceph encoder opto board
EE200	Ceph sensor connector board
T motor	(sensor)

3.4 Schematic diagrams

Isolation diagram




SIGNALS
C10901D
CBCT
flat panel
detector
204821
40
PAN sensor
C10500D
X190
FF detector
40
205206
ED100
EC100
JC104
JC103
204822
40
J3208
J3215
J3204
J3214
J3205
J3203
J3212
J3213
J3210
J3201
J3202
J3211
R3200
CPU
clk,ena,dir//N
204790
6
clk,ena,dir//Coll
204791
6
clk,ena,dir//Det
6
204788
Gigabit ethernet
10/100 Mbs
J5101
R5100
stepper mod
J5102
204944
M
N-movement 3ph motor
204953
Collimator 3ph motor
204948
Detector module 3ph motor
Rotator
EB200
JB204
JB202
204857
Head support
204872
2
Detector position switch
MSW2
204872
sclk1, sclk2, data1,
data2, D01, D02,
cs1, cs2, cs3, cs4,
exp_ena, preh_ena
exp_act,
tubefail
2
2
204794
204793
204798
Shift register
12
5
JG202
JG203
JG207
JG205
JG208
JG214
JG215
JG217
JG210
JG206
JG201
JG204
EG200
XRAY IF
205033
PREH_ENA, EXP_ENA,
XRAY_ENA
3
kV, mA
ref+feedback
9
205032
J3805
R3800
X-ray
generator
J3810
J3808
J3807
J3809
2
FAN2
high voltage
signals
filament
and feedback
signals
2
7
Tube head
board
EG400
Panel PSU
JG402
JG404
Panel_ENA
Panel_SEL
2
2
204867
JC001
204969
204866
J101
EG100
4
Detector selection optos
205461
R3700
X-RAY
PSU
204797
205007
JC003
TMJ
LI300
2
2
4
4
J101
EG100
Collimator optos
204865
J101
EG100
N-movement optos
EXP
204152
204155
Semoflex EI-C
6x0.25mm2
ENC_SYNC
204152
Lower shelf
Layer
LI300
205412
JB-Layer
JB-LayerExt
CBCT
Top of FOV
(optional)
CBCT
Bottom of FOV
(optional)
LI300
LI300
JB-CT1
JB-CT2
Column/
Carriage
JB005
JB005
JB004
205467
205467
JB-FH
JB-MS
LI300
LI300
204838
204837
J3319
J3318
J3305
2
205200
JE203
JE204
JE205
EE200
2
40
40
205201
CEPH sensor
ED200
C10502D
X190
FF detector
Scanning optos
Sec
Det
EE100
EE100
JE101
JE101
4
4
205202
205200
clk,ena,dir//sc
Scanning 3ph motors
J3204
J3203
J3214
204814
6
204815
6

Y-motor optos

X 3ph motor

M

R5100 stepper mod J5101

EG100 J101

204950

x-motor optos

Upper shelf

Rotator

204936

M

Rotator

clk,ena,dir //X Mot

6

4

204808

Ethernet switch

204883

205036

GUI PC

10/100 Mbs

204841

J3403

J3419

J3418

4

R3400 IO 2

205064

205905

3

Mains voltage range

JA305 JA301

EA300 Extension Board JA304 JA303 JA302 JA306 JA309 JA307 JA310

2

2

204824

EMERGENCY SAFETY SW

12

J3401

J3420

JA308

12

J3409

J3410

J3406

205412

204939

205412

3

4

Patient positioning device IF (VT)

M

Chin rest 3ph motor

EG100 J101

Chin rest motor optos

Lower shelf

Patient positioning panel, right (YZ, PIO, Start, laser) LEDs

Patient positioning panel, left (YZ, PIO, Start, laser) LEDs

204839

Z-MOTOR

AC Motor M

Hall sensor

3

3

J3413

J3407

204827

Z-motion limit switches

4

J3417

204929

205200

205202

2

JE003

205202

205477

Nasion support (Pot slide)

JG402

EG400 Panel PSU

LI300

2

EMERGENCY SAFETY SW

Z

JE002

Patient positioning panel (Z, laser)

Ceph

JE004

205856

205285

(without ceph option a jumper is needed for closing the emergency safety switch loop)

JB006

4

204156

Gigabit ethernet

JA001

Work Station

205063

Warning light

2

F3

J1003 Warning Light

204862

2

EXP

JA206 JA209 JA207

J1003

Exposure switch

204861

Mains voltage detection

2

JA213

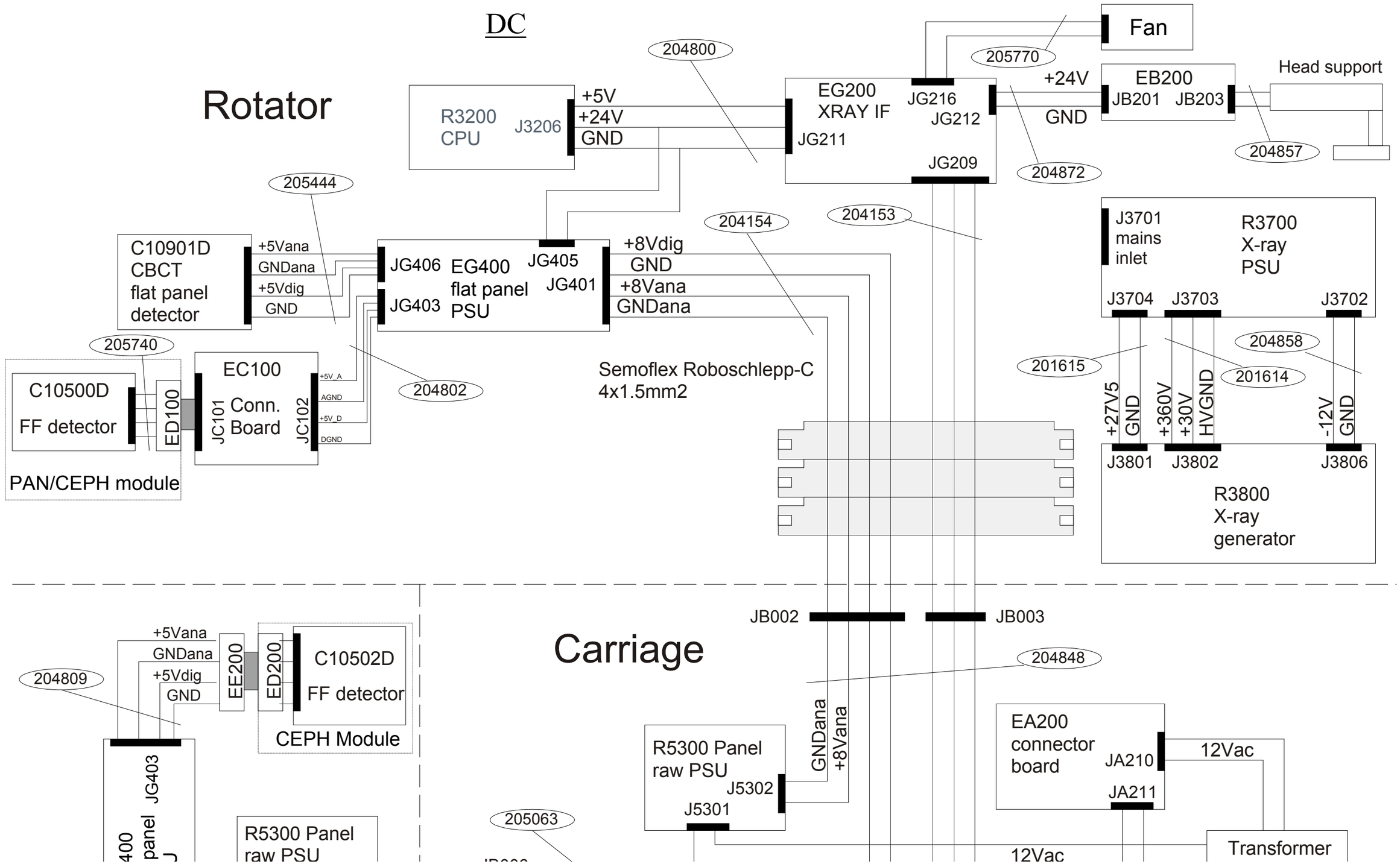
EA200 Connector Board

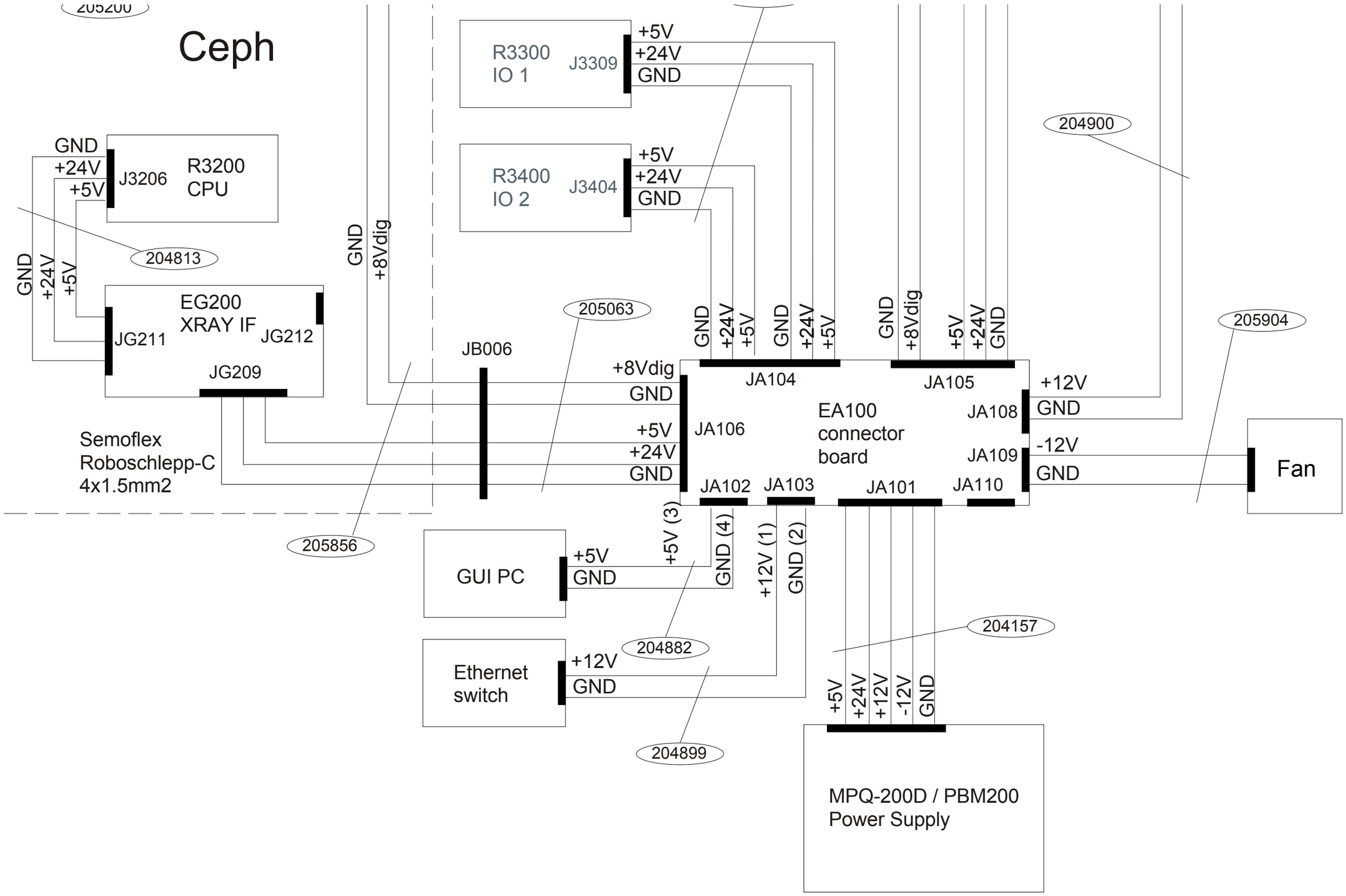
2

EXP

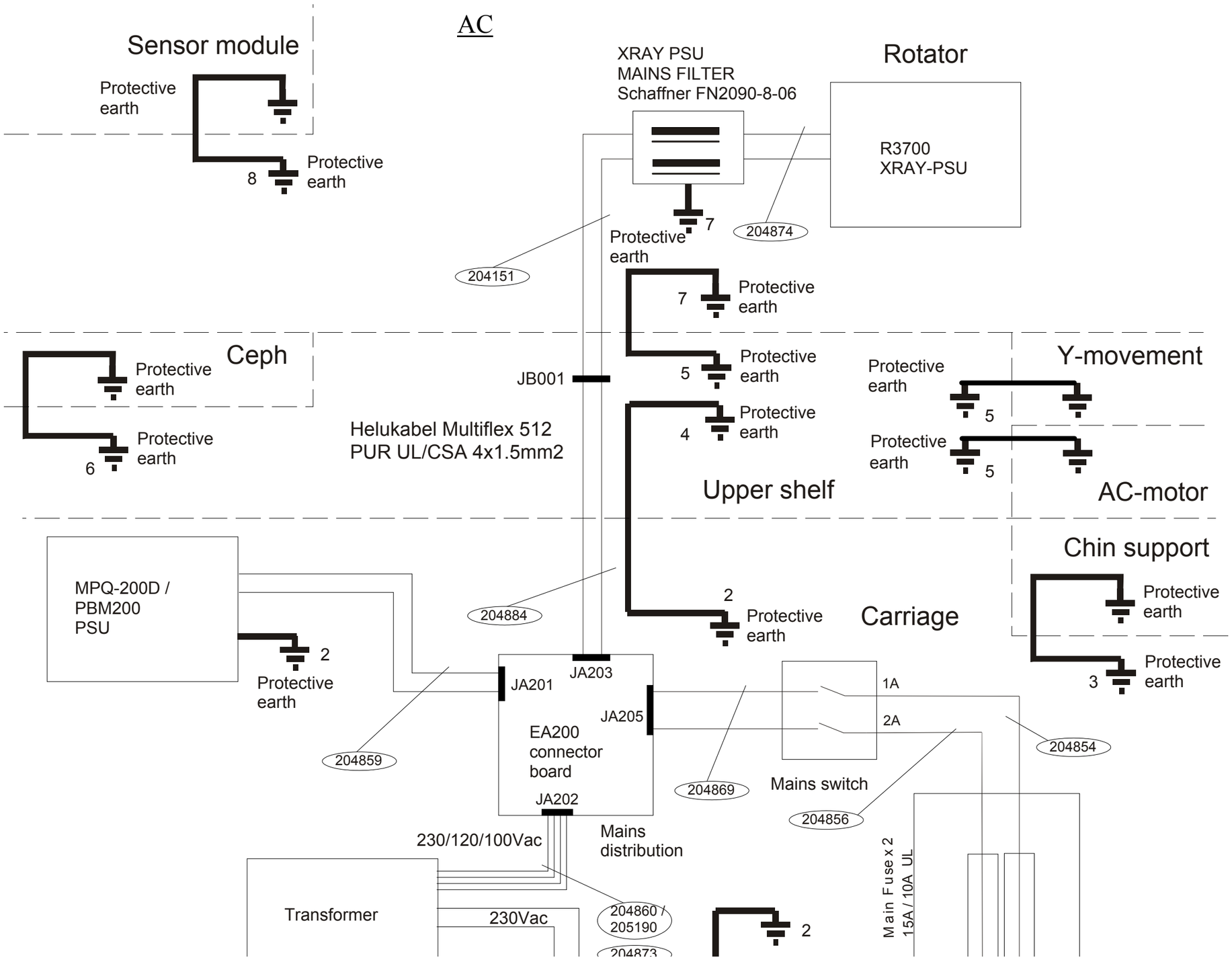
JA204 J3908

JA212

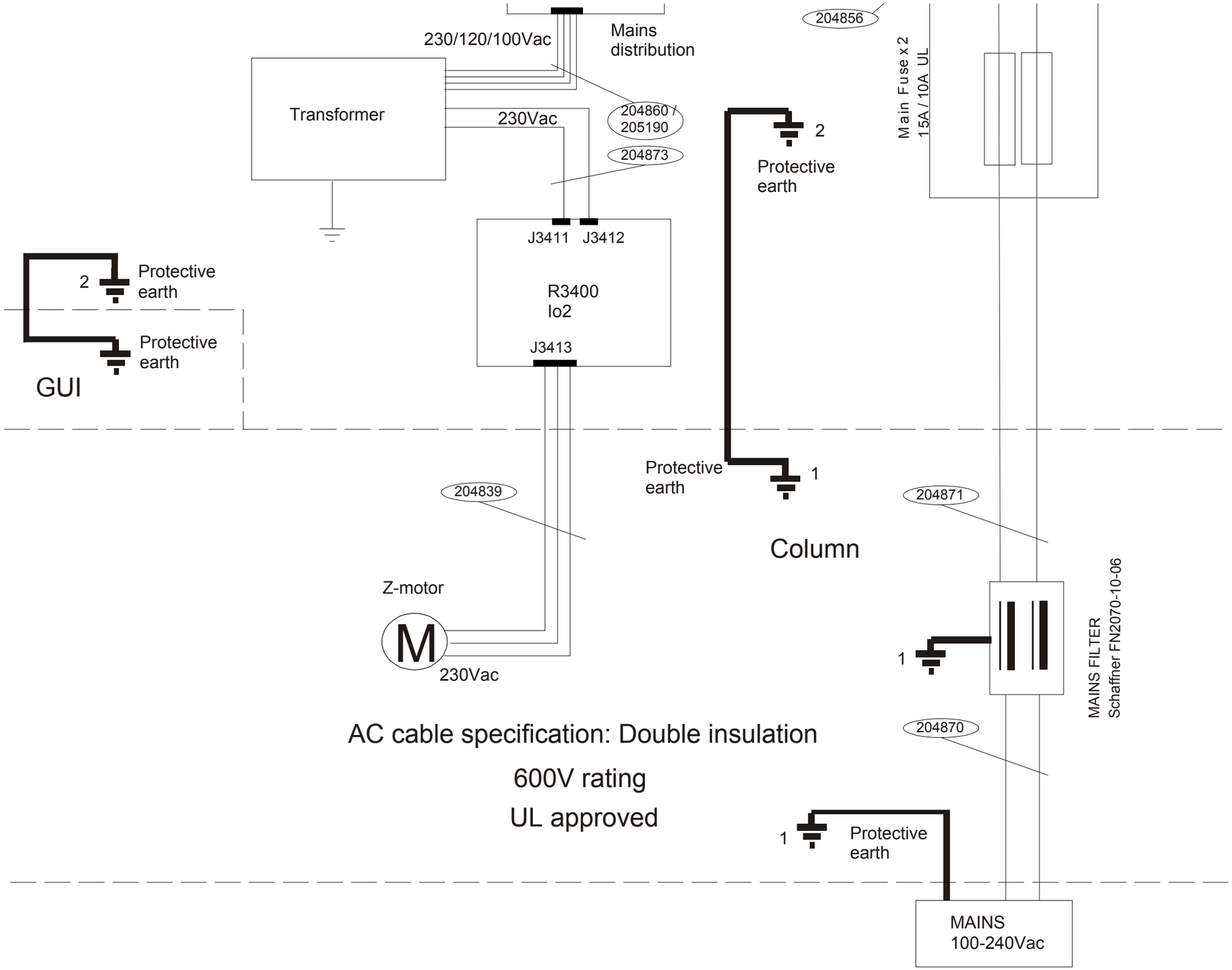

DC
Rotator
R3200
CPU
J3206
+5V
+24V
GND
204800
EG200
XRAY IF
JG216
JG212
JG211
JG209
Fan
205770
+24V
GND
EB200
JB201
JB203
Head support
204857
204872
205444
C10901D
CBCT
flat panel
detector
+5Vana
GNDana
+5Vdig
GND
JG406
JG403
EG400
flat panel
PSU
JG405
JG401
+8Vdig
GND
+8Vana
GNDana
204154
204153
J3701
mains
inlet
R3700
X-ray
PSU
J3704
J3703
J3702
205740
C10500D
FF detector
ED100
EC100
JC101
Conn.
Board
JC102
+5V_A
AGND
+5V_D
DGND
204802
PAN/CEPH module
Semoflex Roboschlepp-C
4x1.5mm2
204858
201615
201614
+27V5
GND
+360V
+30V
HVGND
-12V
GND
J3801
J3802
J3806
R3800
X-ray
generator
JB002
JB003
Carriage
204809
+5Vana
GNDana
+5Vdig
GND
EE200
ED200
C10502D
FF detector
CEPH Module
204848
R5300 Panel
raw PSU
J5302
J5301
GNDana
+8Vana
EA200
connector
board
JA210
JA211
12Vac
Transformer
205063
R5300 Panel
raw PSU
12Vac


205200
Ceph
R3300
IO 1
J3309
+5V
+24V
GND
R3400
IO 2
J3404
+5V
+24V
GND
204900
GND
+24V
+5V
J3206
R3200
CPU
204813
GND
+24V
+5V
EG200
XRAY IF
JG211
JG212
JG209
GND
+8Vdig
205063
JB006
GND
+24V
+5V
GND
+24V
+5V
JA104
GND
+8Vdig
+5V
+24V
GND
JA105
205904
+8Vdig
GND
+5V
JA106
+24V
GND
EA100
connector
board
JA108
+12V
GND
JA109
-12V
GND
Fan
Semoflex
Roboschlepp-C
4x1.5mm2
JA102
JA103
JA101
JA110
205856
+5V (3)
GND (4)
+12V (1)
GND (2)
GUI PC
+5V
GND
204882
Ethernet
switch
+12V
GND
204157
+5V
+24V
+12V
-12V
GND
204899
MPQ-200D / PBM200
Power Supply

Mains power wiring 1



Mains power wiring 2



3.5 Circuit board descriptions

3.5.1 R3210 CPU (Central Processing Unit)

DESCRIPTION:

There is one board in each base unit but two if the CEPH unit exists.
The first one is for the central control of the unit including functions for panorama and 3D image acquisition as well as motion and x-ray control. The gateway to external data communication is handled by the R3210 through the 1GB Ethernet connection (J3210).
The second one is used for CEPH imaging and it manages related motion and image grabbing in the CEPH head. Note that the R3210 in the CEPH unit acts like any other IO boards (R3300 /R3400) and it communicates through the internal 100MB fast Ethernet connection (J3211).

LOCATION:

The main R3210 is located on the top of the rotating unit (in the sensor side).
The CEPH R3210 is located inside of CEPH unit.

CONTROL FUNCTIONS:

Main R3210:
System control,
1Gb Ethernet for external communications,
100Mb Ethernet for internal communications,
3D-image grabbing,
Panorama image grabbing,
Image buffering in the DDRAM memory,
N-motion control signaling,
Collimator control signaling,
Sensorensor swap control signaling,
Exposure control signaling

Note! *If R3210 Main CPU is changed, order it from the manufacturer with the required serial number.*

3.5.2 CEPH R3210

DESCRIPTION:

CEPH image capturing,
Image buffering in the DDRAM memory,
Image calculation,
Sensor motion signaling,
Secondary collimator motion signaling

FUSES:

None

INDICATOR LEDS:

Giga Ethernet status indicators:

D1	Duplex mode
D2	1GB
D3	100MB
D4	10MB
D5	Link activity

100Meg Ethernet status indicators:

D6	100MB
D7	Link activity
D8	Link OK

Motor power status:

D9	+24V switched ON
D10	+5V switched ON

Internal power status:

D11	+5V input OK
D13	+1.25V OK
D14	+1.2V PLL OK
D15	+1.8V OK
D16	+2.5V OK

Special purposes:

D18 - D25 are used for special purpose and no specific meanings exist.

TEST PINS:

None

3.5.3 R3300 IO1 (Input/Output 1)

DESCRIPTION:

IO board used mainly for interfacing with stepper motors and lights. Includes an FPGA integrated circuit and embedded SW.

LOCATION:

In the column / carriage.

FUNCTIONS:

Rotation motor and position detection
X motor and position detection
Y motor and position detection
Layer, FH, Midsagittal and 3D lights
Mains voltage measurement
X-ray warning alarm.

INPUTS:

+24Vdc,	mainly for motors
+5V,	for logic

FUSES:

None

INDICATOR LEDS:

D3	+1,25V
D4	+3,3V

TEST PINS:

TP7	GND
TP10	GND
TP11	POWGND
TP12	GND
TP13	GND
TP14	GND

3.5.4 R3400 NGEO IO2 (Input/Output 2 Board)

WARNING!
Dangerous mains voltage on part of this board.
The dangerous part is marked with crosshatched lines.
LA1 also indicates when there is live voltage on the board.

DESCRIPTION:

The operation of external IO2 board is controlled via the internal Ethernet.

LOCATION:

In the column / carriage.

FUNCTIONS:

100Mb Ethernet for internal communication,
Remote control interface,
Emergency stop interface,
Z-motor safety logic and motor driving,
Chin motor driving,
Chin motor encoder (optos),
Patient positioning panel LED driver,
Patient positioning device (VT) interface.

FUSES:

F1	T5A 250V, 6 x 32

INDICATOR LIGHT:

LA1	Light indicates dangerous voltage (mains) ON = **DANGER**: Mains voltage present OFF = No voltage

INDICATOR LEDS:

D1	3.3V
D2	1.25V
D3	Exposure switch pressed indicator
D4	Z-ENA_ETH
D5	Z-DOWN_ETH
D6	Z-UP_ETH
D15	Z-UP
D16	Z-DOWN
D18	Z-ENA
D30	Z-LOW LIMIT
D31	Z-UPPER LIMIT
D20	Ethernet LINK OK
D21	Ethernet Speed (On=100MB, Off=10MB)
D22	Ethernet Transferring Activities

TEST PINS:

TP1	GND
TP3	+3,3V

3.5.5 R3700 X-Ray power supply

WARNING!
Dangerous mains voltage on part of this board.
LA1 also indicates when there is live voltage on the board.

DESCRIPTION:
Generates the voltages for the R3800 X-ray Generator.

LOCATION:
In the tubehead side of the rotating unit.

FUSES:

F1	T2A 250V
F2	FF8A 500V
F3	T1A 250V

INPUTS:
Mains voltage input

OUTPUTS:
Non-mains isolated +30Vdc

Isolated	+27.5Vdc
Isolated	-15Vdc

INDICATOR LIGHTS:

LA1	Light indicates dangerous voltage (mains) ON = **DANGER**: Mains voltage present OFF = No voltage

INDICATOR LEDS:

D13	+27,5V
D20	-15V
D11	Line voltage over 160V indicator

TEST PINS:
None

3.5.6 R3800 X-Ray generator

WARNING!
Dangerous mains voltage on part of this board.
LA1 also indicates when there is live voltage on the board.

DESCRIPTION:

The board has two main functions:
To generate 360Vp-p AC voltage for tubehead from the mains supply voltage, 230 VAC, and to generate the filament voltage for the tubehead and the feedback signals.

LOCATION:

In the tubehead side of the rotating unit.

FUSES:

None

INDICATOR LIGHTS:

LA1	Light indicates dangerous voltage (mains) ON = **DANGER**: Mains voltage present OFF = No voltage

INDICATOR LEDS:

D1	FIV Filament power supply
D2	+15V
D3	PREH
D30	+15Vdc HV
D31	EXP (3D flashing, pan constant)
D32	FAIL

TEST PINS:

TP1	15V
TP2	HVGND
TP3	High Voltage (HV) BRIDGE FETDRIVE FETAD
TP4	HV BRIDGE FETDRIVE FETBC
TP5	FAN_OVERRIDE, Not assembled
TP6	Exposure Enabled (EXPENA)
TP7	KVFB
TP8	KVREF
TP9	Not for service use
TP10	GND
TP11	PREHREF
TP12	MAREF
TP13	MAFB
TP14	Not for service use
TP15	PREHFB
TP16	GND

kVfb	= 20 kV/V (eg. 60 kV = 3V)
mAfb	= 3.56 mA/V (eg. 8 mA = 2.25V)

3.5.7 R5100 3-Phase stepper driver

DESCRIPTION:

Is used to drive a stepper motor according to a digital input signal.

LOCATION:

Close to each stepper motor.

FUSES:

None

INDICATOR LEDS:

D1	+5V
D2	+28V

TEST PINS:

GND
Vref
clk
ENA
dir

3.5.8 R5300 Panel raw power supply

DESCRIPTION:

There is one board in each base unit but two if the CEPH unit exists.
The first one generates +8V low voltage for the analog side of the 3D and panorama sensor power chains.
The second one generates +8V low voltage for the analog side of the CEPH sensor power chains.

NOTE! *The +8V is distributed to the EG400 power supply, which re-regulates it down to +6V for panorama / CEPH sensors and down to +5V for the 3D sensor.*

LOCATION:

First one is located in the vertical carriage for the 3D and panorama sensors.
Second one is located in the CEPH unit for the CEPH sensor.

INPUTS:

12Vac

OUTPUTS:

+8Vdc (analog side)

FUSES:

F1 T2A/250V 6 x 32

INDICATOR LEDS:

H1 = 12Vac (input)
H2 = +8V (output)

TEST PINS:

None

3.5.9 EA100 Power distribution board

DESCRIPTION:

EA100 removes noise from the PSU output (MPQ200D or equivalent) and distributes it to various parts of the system. Digital +8V raw panel voltage is also regulated from +12V input. Board includes two 12V-connectors for chassis fans.

LOCATION:

In the bottom part of the column inside metal shield box together with EA200 and the PSU.

FUNCTIONS:

Noise filtering from SMPS output.
Distribution of DC voltages.
+8V regulation.

FUSES

F1	5x20mm 1AT UL
F2	5x20mm 10AT UL (automatic fuse from revision 4)
F3	5x20mm 4AT UL

NOTE!

When changing/checking fuses, make sure that fuses and fuse holder metallic contact surfaces are clean. Tighten fuses properly so that good electrical contact is achieved.

INPUTS:

+5Vdc
+24Vdc
+12Vdc
-12Vdc

Optional 12Vac for +8V generation instead of 12Vdc. Selectable with jumper JP2.

OUTPUTS:

+5Vdc
+24Vdc
-12Vdc
+12Vdc
+8Vdc

INDICATOR LEDS:

H5	+5V
H6	+24V
H7	-12V
H8	+12V
H9	+8V

JUMPERS:

JP1 1&2, 3&4 shorted: regulate +8V from SMPS (normal operation)

JP2 1&2, 3&4 shorted: regulate +8V from +12Vac input

NOTE!

Do not install jumpers on JP1 & JP2 simultaneously!

TEST PINS:

TP1	+5V IN
TP2	+24V IN
TP3	-12V IN
TP4	+12V IN
TP5	+5V OUT
TP6	+5V OUT GND
TP7	+24V OUT
TP8	+24V OUT GND
TP9	-12V OUT
TP10	-12V OUT GND
TP11	+12V OUT
TP12	+12V OUT GND
TP13	+12V RAW
TP14	+12V RAW GND
TP15	+8V OUT
TP16	+8V OUT GND
TP16	INPUT GND

3.5.10 EA200 Connector board

DESCRIPTION:

The main function is to distribute AC voltage from the mains switch (main power supply) to the:
- 100/120/230/12Vac transformer
- to MPQ-200D/PBM200 power supply
- to R3700 X-ray power supply

EA200 is also used as a connector board for EXP signal disribution(to R3400/EG200) and a relay for the external warning light.

EA200 is also used for detecting mains voltage AC level.

LOCATION:

Board is located in the lower part of the vertical carriage.

INPUTS:

Exposure switch signal

Relay Vcc

AC input (230/120/100Vac)

Mains detection voltage(12Vac) from transformer

OUTPUTS:

Exposure switch signal to R3400

Exposure switch signal to EG200

Warning light relay terminal

Mains to MPQ-200D/PBM200

Mains to R3700 X-ray power supply

Mains detection signal to r3300

100/120/230Vac to Transformer

FUSES:

F1 Slowblow 8A/250V, 6x32mm

INDICATOR LIGHTS:

H1 Light indicates the existence of the mains voltage.
ON = **DANGER**: Voltage more than 65V
OFF = Voltage less than 65V

INDICATOR LEDS:

D22 indicates the existence of the 12Vac mains voltage measuring voltage.

TEST PINS:

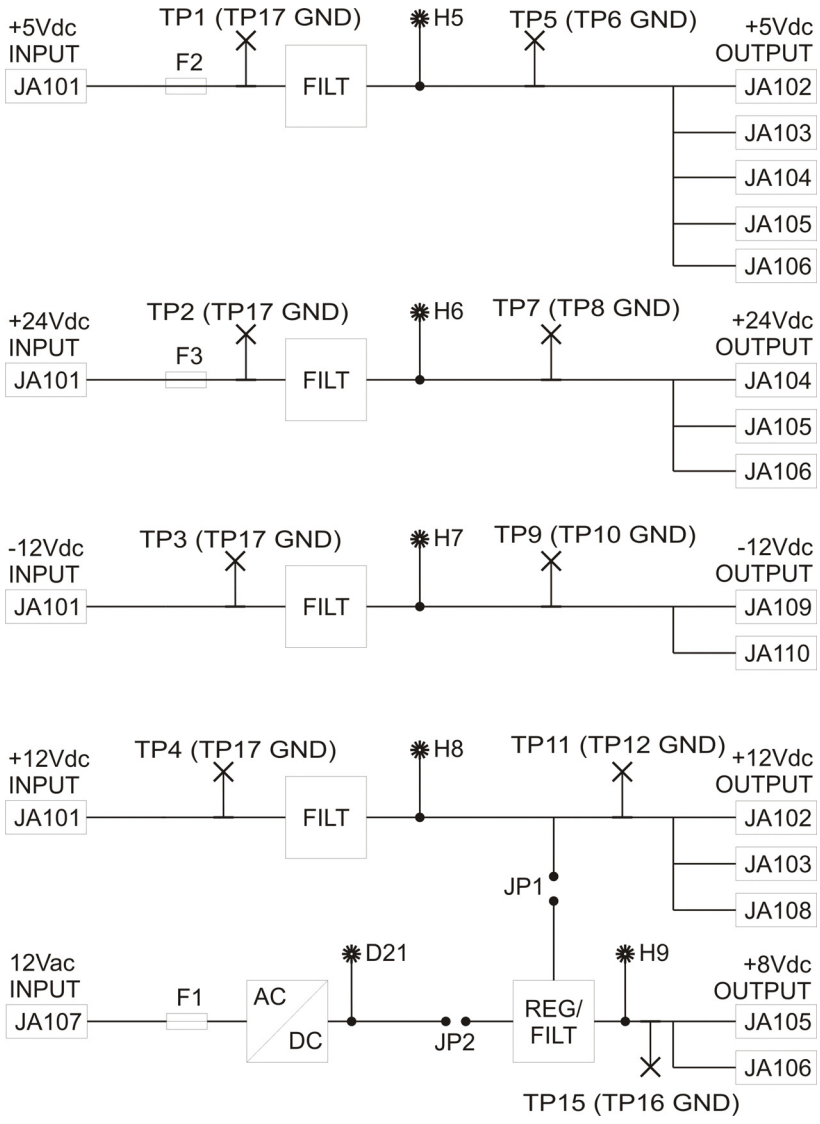
TP1 Ground

Test point for secondary side grounding.

NOTE!

Not suitable for measuring the mains side grounding.

EA200 Block diagram



3.5.11 EA300 Connector board

DESCRIPTION:

Is used as an interface between the R3400 NGEO IO2 and patient positioning panels.

LOCATION:

Daughter board for the R3400 NGEO IO2

FUNCTIONS:

Emergency stop interface (chin support)

Emergency stop interface (CEPH).

Patient positioning left side panel interface.

Patient positioning right side panel interface.

Patient positioning CEPH interface.

Patient positioning left side panel LEDs driver.

Patient positioning right side panel LEDs driver.

FUSES:

None

INDICATOR LIGHTS:

None

TEST PINS:

None

3.5.12 EB100 Rotator opto board

DESCRIPTION:

EB100 has four optoswitches and is used for rotator position (HOME, MIDDLE, ENC1, ENC2) detection.

LOCATION:

In the upper shelf above the rotating unit.

FUNCTIONS:

Four optoswitches for position detection.

INPUTS:

+3.3Vdc for optoswitch LEDs

OUTPUTS:

Optoswitch outputs

INDICATOR LEDS:

None

TEST PINS:

None

3.5.13 EB200 Head support board

DESCRIPTION:

There is one of these boards in the unit. It works as a connector board for headsupport microswitches and headsupport lock release buttons. Board also has headsupport magnetic lock.

LOCATION:

In the top part of the rotating unit.

FUSES:

None

INDICATOR LEDS:

None

TEST PINS:

None

3.5.14 EC100 Pan sensor connector board

DESCRIPTION:

EC100 routes image data from the panoramic x-ray image sensor assembly and provides operating voltages and control signals to the sensor. Device-side connector that docks the sensor to the main unit is mounted on this board.

LOCATION:

In the panoramic sensor mount assembly.

FUNCTIONS:

Signal routing from x-ray sensor assembly to the main unit via docking connector.

INPUTS:

Image data and control signals to/from sensor.
+6V analog and digital operating voltages.

OUTPUTS:

Image data and control signals to/from sensor
+6V analog and digital operating voltages.

INDICATOR LEDS:

None

TEST PINS:

None

3.5.15 ED100 Pan sensor connector board

DESCRIPTION:

ED100 routes image data from the panoramic x-ray image sensor and provides operating voltages and control signals to the sensor. Connector that docks the sensor to the main unit is mounted on this board.

LOCATION:

Inside panoramic x-ray image sensor.

FUNCTIONS:

Signal routing from x-ray sensor to the main unit via docking connector. Final voltage regulation for the sensor.

INPUTS:

Image data and control signals to/from sensor.
+6V analog and digital operating voltages.

OUTPUTS:

Image data and control signals to/from sensor.
+5V analog and digital operating voltages.

INDICATOR LEDS:

None

TEST PINS:

None

3.5.16 ED200 Ceph sensor connector board

DESCRIPTION:

ED200 routes image data from the cephalometric x-ray image sensor and provides operating voltages and control signals to the sensor. Connector that docks the sensor to the main unit is mounted on this board.

LOCATION:

Inside cephalometric x-ray image sensor.

FUNCTIONS:

Signal routing from x-ray sensor to the main unit via docking connector. Final voltage regulation for the sensor.

INPUTS:

Image data and control signals to/from sensor.
+6V analog and digital operating voltages.

OUTPUTS:

Image data and control signals to/from sensor.
+5V analog and digital operating voltages.

INDICATOR LEDS:

None

TEST PINS:

None

3.5.17 EE100 Ceph encoder opto board

DESCRIPTION:

EE100 has three optoswitches and is used for cephalostat head sensor position and secondary collimator position (HOME, ENC_A, ENC_B) detection.

LOCATION:

Two in the cephalostat head; one in moving sensor assembly, another one in moving secondary collimator assembly.

FUNCTIONS:

Three optoswitches for position detection.

INPUTS:

+5Vdc for optoswitch LEDs

OUTPUTS:

Optoswitch outputs in 2.5V logic.

INDICATOR LEDS:

None

TEST PINS:

None

3.5.18 EE200 Ceph sensor connector board

DESCRIPTION:

EE200 routes image data from the cephalometric X-ray image sensor assembly and provides operating voltages and control signals to the sensor. Device-side connector that docks the sensor to the main unit is mounted on this board.

LOCATION:

In the cephalometric sensor mount assembly.

FUNCTIONS:

Signal routing from x-ray sensor assembly to the main unit via docking connector.

INPUTS:

Image data and control signals to/from sensor.
+6V analog and digital operating voltages.

OUTPUTS:

Image data and control signals to/from sensor.
+6V analog and digital operating voltages.

INDICATOR LEDS:

None

TEST PINS:

None

3.5.19 EG100 Dual opto board

DESCRIPTION:

EG100 has two optoswitches and is used for position (LIMIT, MIDDLE) detection in various movements of the unit.

LOCATION:

Two in the upper shelf (X-, Y-movements). Two in the rotating unit (N-, Collimator-movements). One in the lower shelf (Chin support movement).

FUNCTIONS:

Two optoswitches for position detection.

INPUTS:

+3.3Vdc for optoswitch LEDs

OUTPUTS:

Optoswitch outputs

INDICATOR LEDS:

None

TEST PINS:

None

3.5.20 EG200 Interface board

DESCRIPTION:

EG200 is a general I/O-board and includes electronics for controlling the X-ray generator.
There are two pcb's in each unit.

LOCATION:

In the top part of the rotating unit and inside of the cephalo-head.

FUNCTIONS:

X-ray generator control
EXP signal interface
Generator temperature measuring
Interface for optos/micros
Position light modules drive
General i/o-interface
Distribution of +5V/24Vdc voltages

INPUTS:

+5Vdc for logic
+24Vdc for ad/da-converters
Exposure signals from EA200 and R3200
X-ray generator control signals from R3200
NTC-thermistor/Nasio potentiometer input
Feedback signals from x-ray generator
Opto-/microinterfaces
R3200 shiftregister i/o-control interface
General lvttl-interface

OUTPUTS:

X-ray generator control signals
light modules drive
General lvttl-interface
+5Vdc
+24Vdc

INDICATOR LEDS:

D1	+28V
D2	+5V
D3	+5V Xray
D4	+3.3V
D5	Xray Ena
D6	Preh Ena
D7	Exp Ena

TEST PINS:

TP1,3	GND
TP2	POWGND

3.5.21 EG400 Panel power supply

DESCRIPTION:

Generates the low voltages for the PAN/CEPH and 3D sensors.The board regulates the voltages, 8V analog to 6V or 5V analog and 8V digital to 6V or 5V digital, depending on what mode is used. There are also power enables in the circuit. One is external and one is internal. The external P/E is connected to the digital regulation circuit and internal P/E is connected from the digital output to the analog enable. The PAN selecting signal controls the output voltage. On PAN/CEPH mode (default) the output voltages are 6V. When this signal is activated, the EG400 is in 3D mode and output voltages are 5V. The switching circuitry requires an external +24V for power.

LOCATION:

In the sensor head.

INPUTS:

+8Vdc (digital side)
+8Vdc (analog side)
+24Vdc (power for mode switching)
Panel power enable from the EG200 XRAY IF
PAN/3D select signal from the EG200 XRAY IF

OUTPUTS:

+6Vdc (digital side) PAN mode
+5Vdc (digital side) 3D mode
+6Vdc (analog side) PAN mode
+5Vdc (analog side) 3D mode

FUSES:

None

INDICATOR LEDS:

D3 digital
D4 analog

TEST PINS:

D4 analog

3.5.22 Panoramic sensor (CMOS)

DESCRIPTION:
Panoramic image acquisition.

LOCATION:
Rotating unit (sensor head)

FUSES:
None

INDICATOR LEDS:
None

3.5.23 3D sensor (CMOS)

DESCRIPTION:
3D image acquisition.

LOCATION:
Rotating unit (sensor head)

FUSES:
None

INDICATOR LEDS:
None

3.5.24 Ethernet switch/router

DESCRIPTION:
Ethernet traffic routing

LOCATION:
In the upper shelf.

FUSES:
None

INDICATOR LEDS:
D1-D5

OFF = no connection
ON = link connection OK (no traffic)
FLASH = link connection OK (traffic)

3.6 Replacing the boards

Following is a list what should be checked/calibrated after replacing certain parts on the system. In addition, Quality Check (QC) images of all modalities should be taken and inspected every time after replacing any part on the system.

EG200 X-ray Interface Board (rotating unit)

1. Generator power supply temperature sensor check
2. Preheat calibration
3. mA calibration

EG200 X-ray Interface Board (ceph head)

1. Check operation of all cephalostat patient positioning panel buttons
2. Soft tissue filter calibration
3. Take lateral ceph images to test soft tissue filter operation (by moving nasion support)

EG400 Panel PSU (rotator unit)

1. Pan pixel calibration
2. 3D pixel calibration

EG400 Panel PSU (ceph)

1. Ceph pixel calibration

R3210 CPU Board (in the rotator unit)

1. Upgrade the unit's embedded software. Use automatic update to ensure all software components are compatible. The R3210 CPU board must be separately updated before a full update is done if the replacement board is not preprogrammed with R3210 Main CPU software. Instructions on how to do this are included in the software release package.

2. Perform full calibration of the unit (starting with preheat and mA calibrations)

R3210 CPU Board (ceph)

1. Upgrade the unit's embedded software. Use automatic update to ensure all software components are compatible. The R3210 CPU board must be separately updated before a full update is done if the replacement board is not preprogrammed with R3210 Ceph CPU software. Instructions on how to do this are included in the software release package.

R3300 IO1 Board

1. Upgrade the unit's embedded software. Use automatic update to ensure all software components are compatible.

R3400 IO2 Board

1. Upgrade the unit's embedded software. Use automatic update to ensure all software components are compatible.

R3700 X-Ray Power Supply / R3800 X-Ray Generator Board

1. Preheat calibration
2. mA calibration
3. Pixel calibrations for all modalities

R5300 Sensor Power Supply

1. Pan pixel calibration
2. 3D pixel calibration

R5300 Sensor Power Supply (ceph)

1. Ceph pixel calibration

GUI

1. Upgrade the unit's embedded software. Use automatic update to ensure all software components are compatible.

2. Perform full calibration of the unit.

Panoramic image sensor

1. Pan collimator calibration
2. Pan geometry calibration
3. Pan pixel calibration

3D image sensor

1. 3D collimator calibration
2. Pan collimator calibration
3. 3D geometry calibration
4. 3D pixel calibration

Ceph image sensor

1. Ceph rot angle calibration
2. Ceph rot pos calibration
3. Ceph pix calibration

Tubehead

1. Perform full calibration of the unit (starting with preheat and mA calibrations)

Collimator

1. Perform full calibration of the unit (except preheat and mA calibrations not needed)

4 Firmware description

4.1 Overview

The firmware is located on four components:

- R3210 CPU: Main control, image acquisition, UDP/IP interface to the acquisition PC, collimator, sensor and n (rotation center offset) motor control.

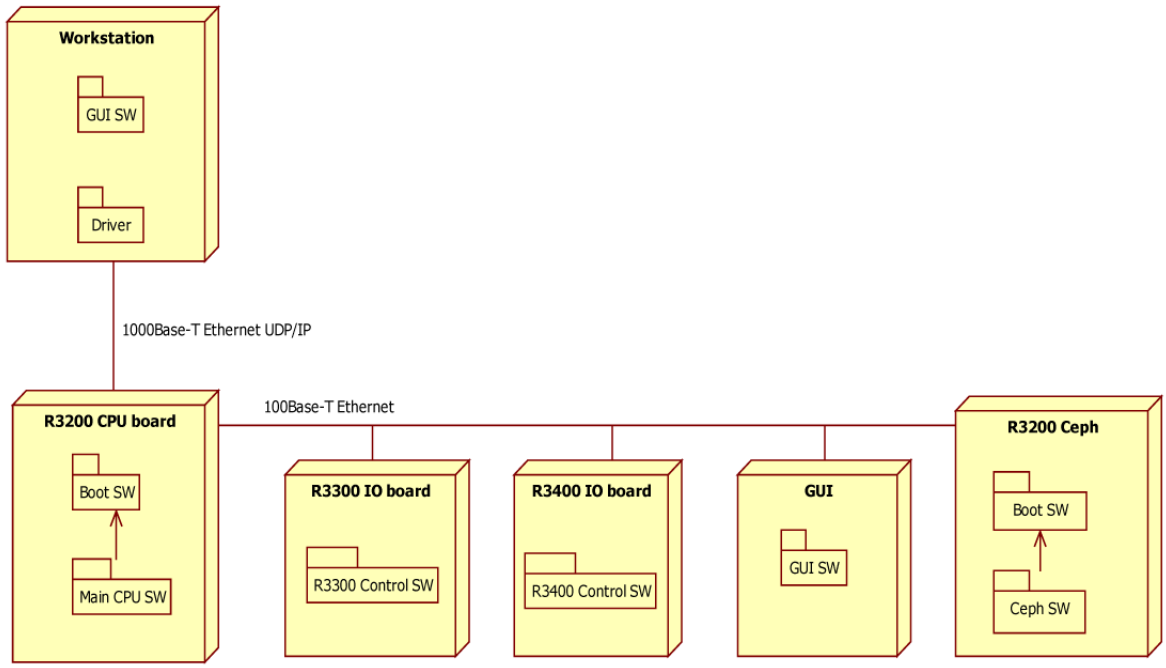
- R3210 Ceph: Ceph movement control and ceph image acquisition.

- R3300 IO1: rotation, x and y motor control, positioning lights.

- R3400 IO2: chin support motor control, Z motor control, positioning lights.

- Touch screen display (the embedded PC): user interface, calibration data.

Communication between the IO boards and touch screen display is via an internal 100 Base-T Ethernet connection.



4.2 Detailed View

R3210 CPU

Executes the main and boot SW of the unit.

Boot software

Loads the main software into the RAM and starts it. Handles the initial unit software loading and boot mode updates.

Main software

Controls and coordinates unit movements, exposure, image acquisition and transfer.

The image data acquired during image capture are stored in the internal memory of the unit. After image acquisition the image data are transferred to the workstation using the external 1000 Base - T Ethernet UDP/IP Ethernet.

It also handles multi connect and up to five clients (drivers, S2Terminals or replicate PC touch screen displays) can be connected to the unit via the external Ethernet.

It also offers firmware upgrade services for itself and software upgrade for touch screen display. It also offers core (FW) update service for R3300 IO1, R3400 IO2 and R3210 Ceph as there is no direct connection from the S2Terminal to these three boards.

R3300 IO1 software

Controls non-critical movements

R3400 IO2 software

Controls non-critical movements, IO, lights etc.
Communicates with CPU over a 100Base-T interface.

Touch screen display software

Holds the unit calibration data that is transfered to the R3210 CPU during start up.

R3210 Ceph CPU

Controls the cephalometric imaging movements on the ceph end (secondary collimator and sensor movements). Controls cephalometric image acquisition.

4.3 Operating modes

Imaging mode

The usual operation mode. X-ray imaging is allowed when patient study is started.

Test mode

Same as the normal imaging mode, except that the X-ray generator is disabled. The image is grabbed but not sent to the driver. Tests the imaging acquisition chain.

Using this mode will delete the last image taken (temporarily stored in the unit memory) making it non-recoverable. Useful when problems with movements, image grabbing etc. need to be investigated.

Test mode activation/deactivation

Using the touch screen display

Activated from touch screen display by touching the ‘T’ key. The T icon on the touch screen display will change to the active state. Deactivate by touching the ‘T’ key again.

Using the s2terminal

Activate by entering the command: ‘testmode 1’. Deactivate by entering the command: ‘testmode 0’.

4.4 Firmware states

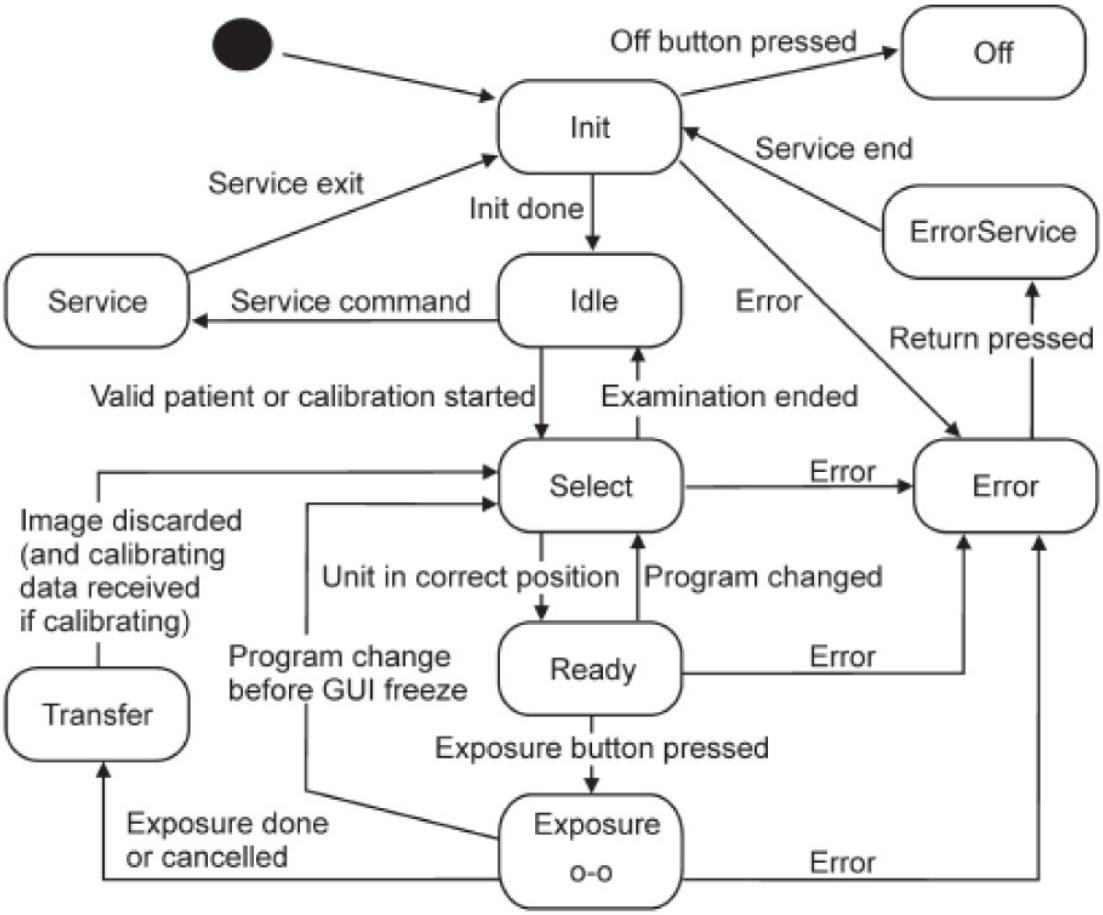
IO cards only have one state. The IO cards wait for commands from the main CPU. After they receive a command they execute the command and send an acknowledgment of its execution to the main CPU.

CPU board (R3210) has several states that perform various checks during operation of the system.

R3210 states

R3210 control state machine has the following states:

- Init (Initialization)
- Idle
- Select (Program select)
- Ready
- Exposure
- Transfer (Image transfer)
- Error
- Error Service
- Off (emergency stop!)



Init (initialization) state

During the initialization state the unit carries out several initializations and checks as follows:

- detects the IO boards
- initializes the generator
- initializes the collimator
- initializes the image buffer and calibration data
- checks states of the sensors
- checks the state of the exposure button
- initializes the movements

Most of the essential functionality of the unit is tested during the initialization state.

Note! *The x-ray generator is not tested.*

Idle state

The unit is waiting for an examination to be started by the driver. The service state can be entered during this state The unit will enter the error state if a system error occurs.

Select (program select) state

The unit initializes the selected program and enters the ready state when system is ready to take an exposure. If the examination is ended, the unit will return to the idle state. The unit will enter the error state if a system error occurs.

Ready state

The unit is waiting for the exposure button to be pressed. Once it notices that the button has been pressed the exposure state is entered.
If the exposure program is changed when the unit is in the ready state, the unit will revert to the select state. The unit will enter the error state if a system error occurs.

Exposure state

The unit carries out the selected exposure program and, when completed, proceeds to the transfer (image transfer) state.

The exposure button is monitored during the exposure. Rotation and sensor movements are also monitored. If a fatal error occurs and no image has been captured the unit will enter the error state. If an image has been captured the unit will enter the transfer state and transfer the image to PC and then enter the error state.

Transfer (image transfer) state

The unit waits for the image transfer to be completed. Any calibration actions are handled if the exposure program was a calibration program.
The exposure counter is updated.
After the driver has received the image it releases it.
It makes sure that exposure button is released and after it has been the unit returns to the select state.

Error state

The unit will enter the error state whenever a system error is encountered. Movements and x-rays are stopped as a precaution. The error log is updated. Service state may be entered using the s2terminal for further diagnosis.

Service state

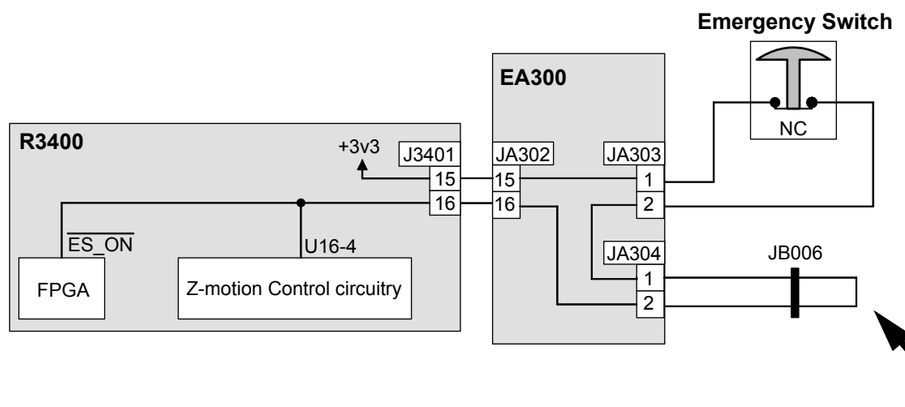
The service state (s2terminal) is entered by giving the service command when the unit is in the error state or idle state.

5 Hardware operation

5.1 Emergency stop

When the emergency stop button is pressed it only effects the Z-movement.
Emergency stop mechanism is on R3400 IO2. The 3.3 voltage from R3400 IO2
is routed through the emergency switch to the Z-motion control circuitry on the R3400 IO2.

Note! *The emergency switch does not cut the power off anywhere else.*



NOTE!

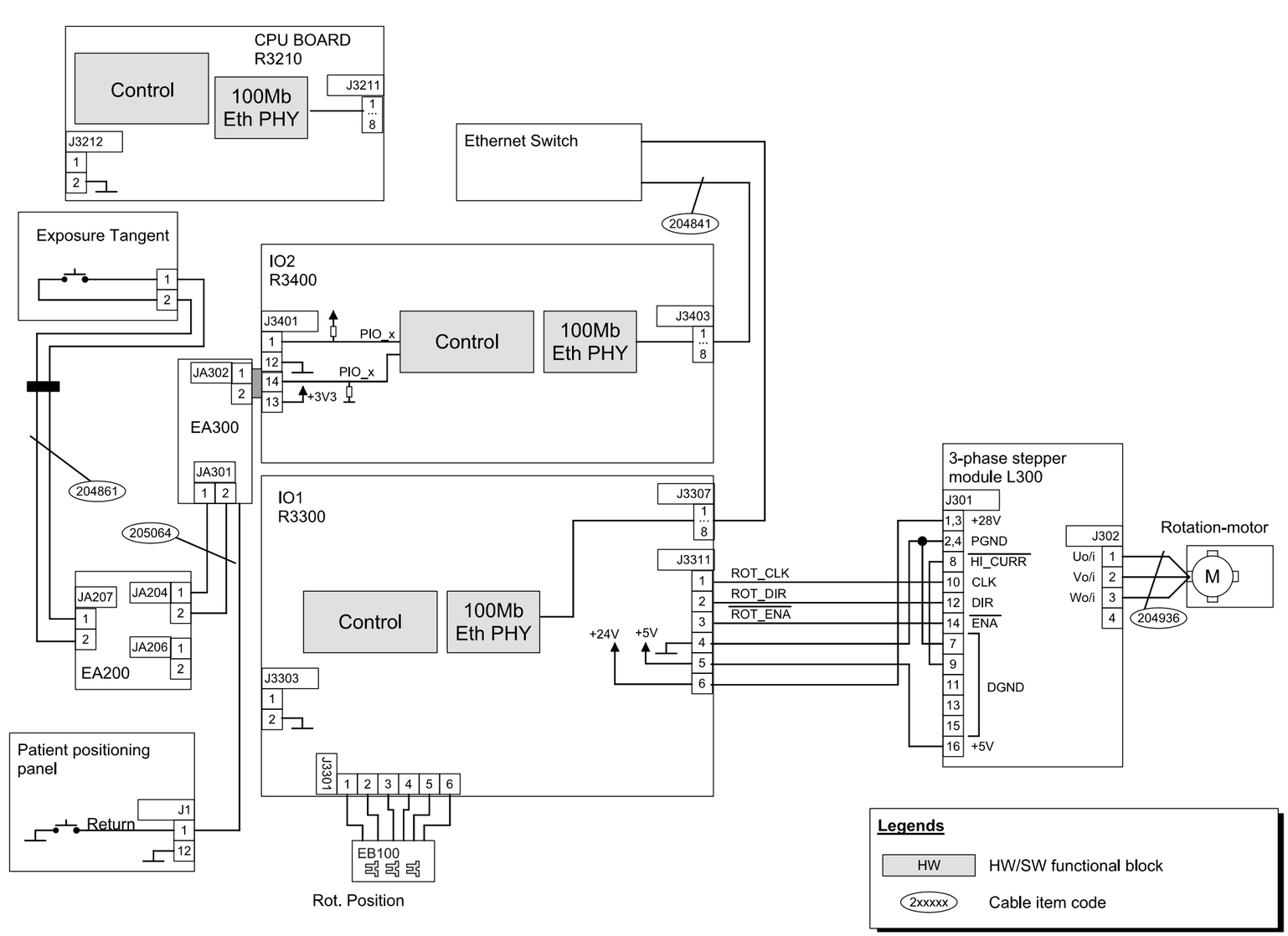
Cephalostat emergency stop wiring is added here when cephalostat is installed.

5.2 Movements

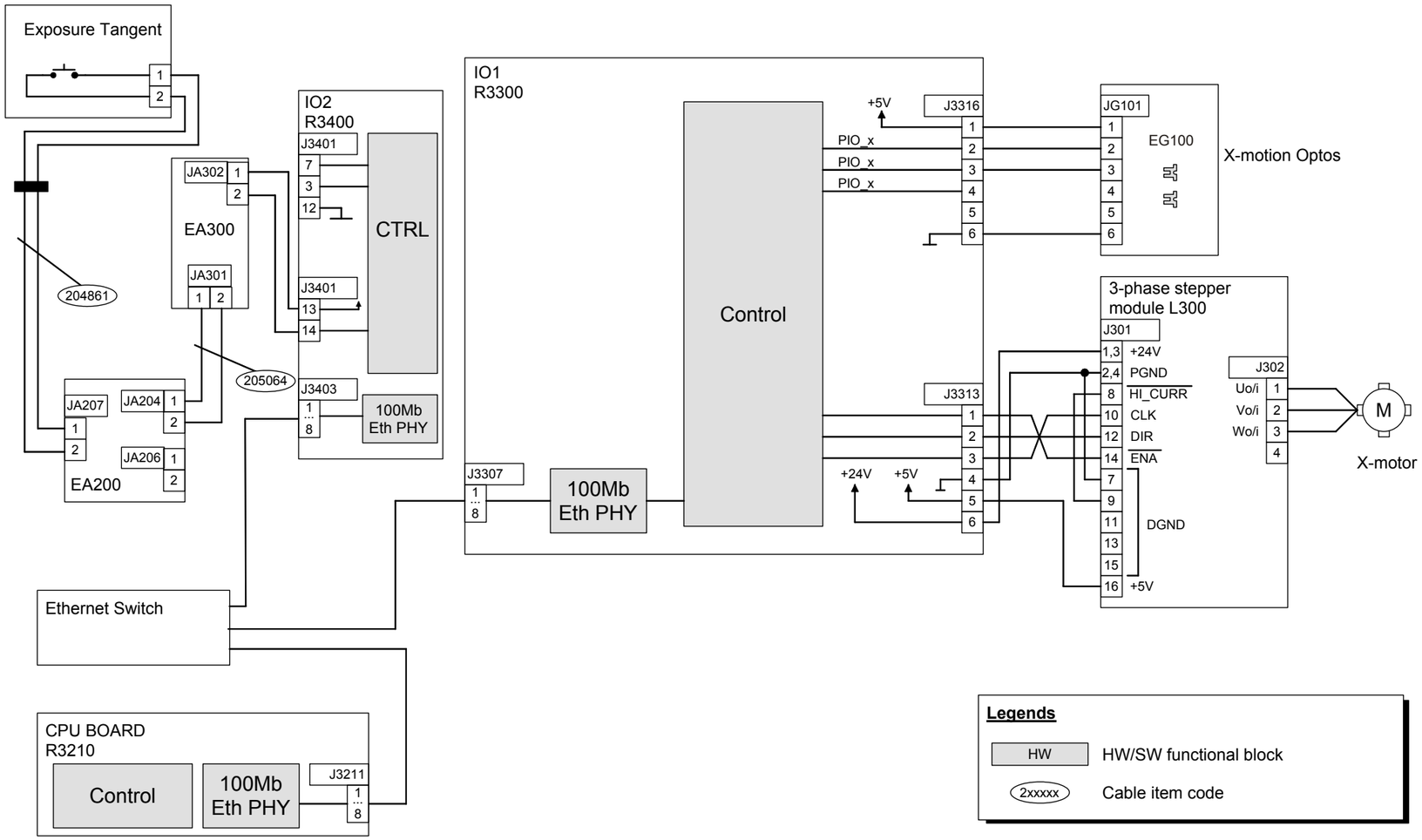
The unit has seven motorized movements. The collimator movements are automatic, but all the other movements are controlled by the user with the remote control and the exposure switch. The Z-movement is double secured with HW (single fault tolerant).

5.3 Rotation movement

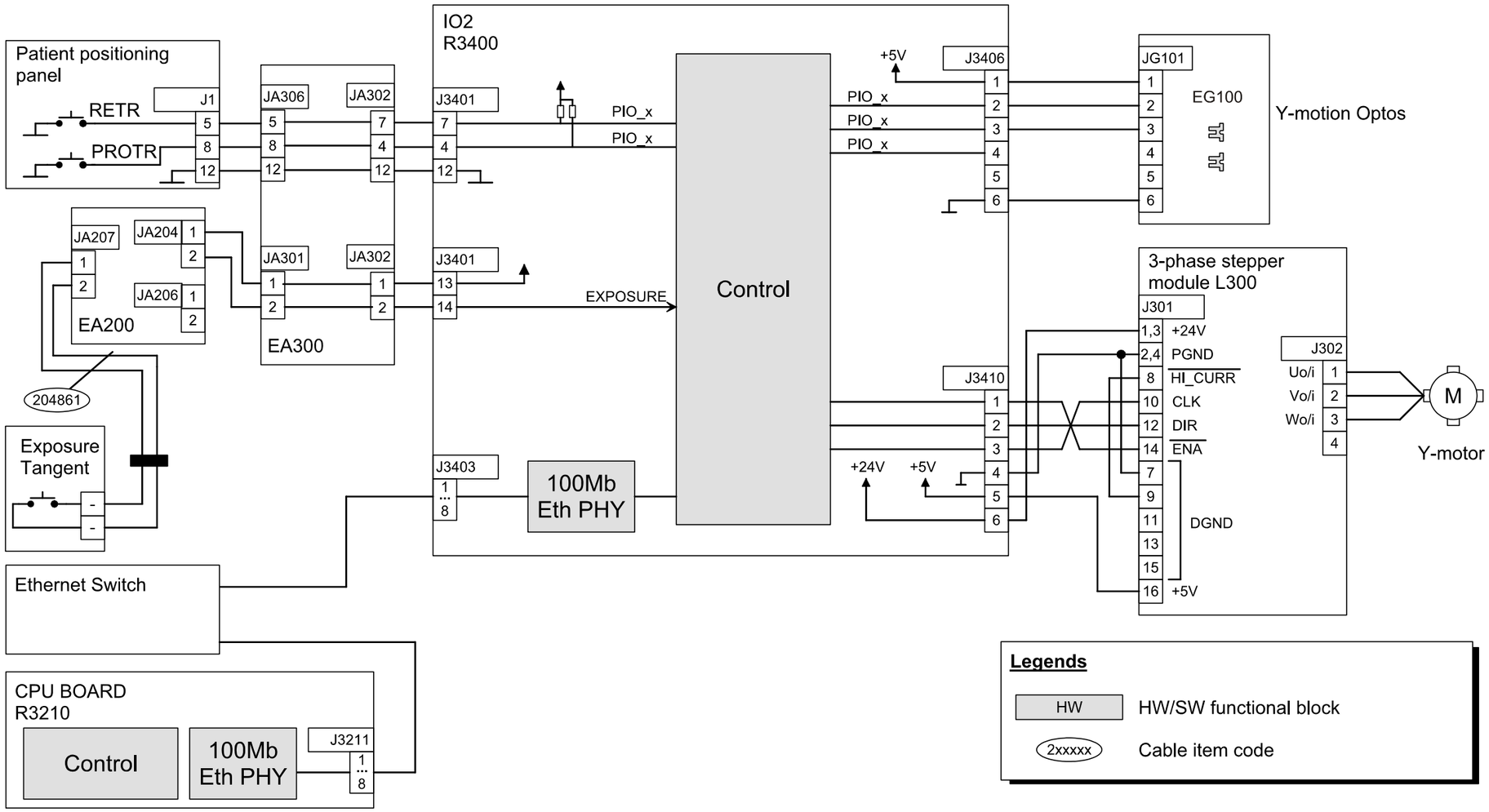
ROTATION CHAIN



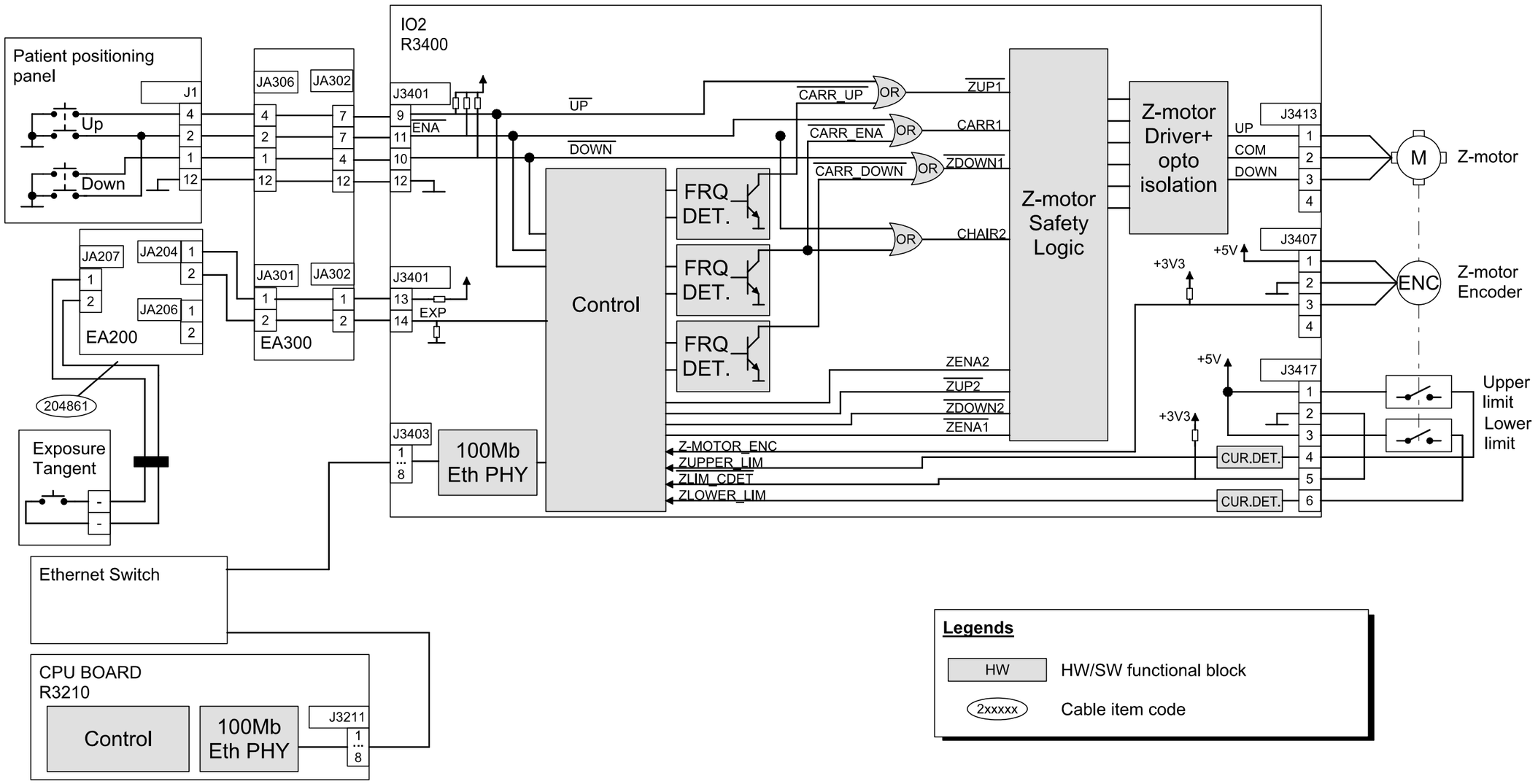
5.4 X-movement



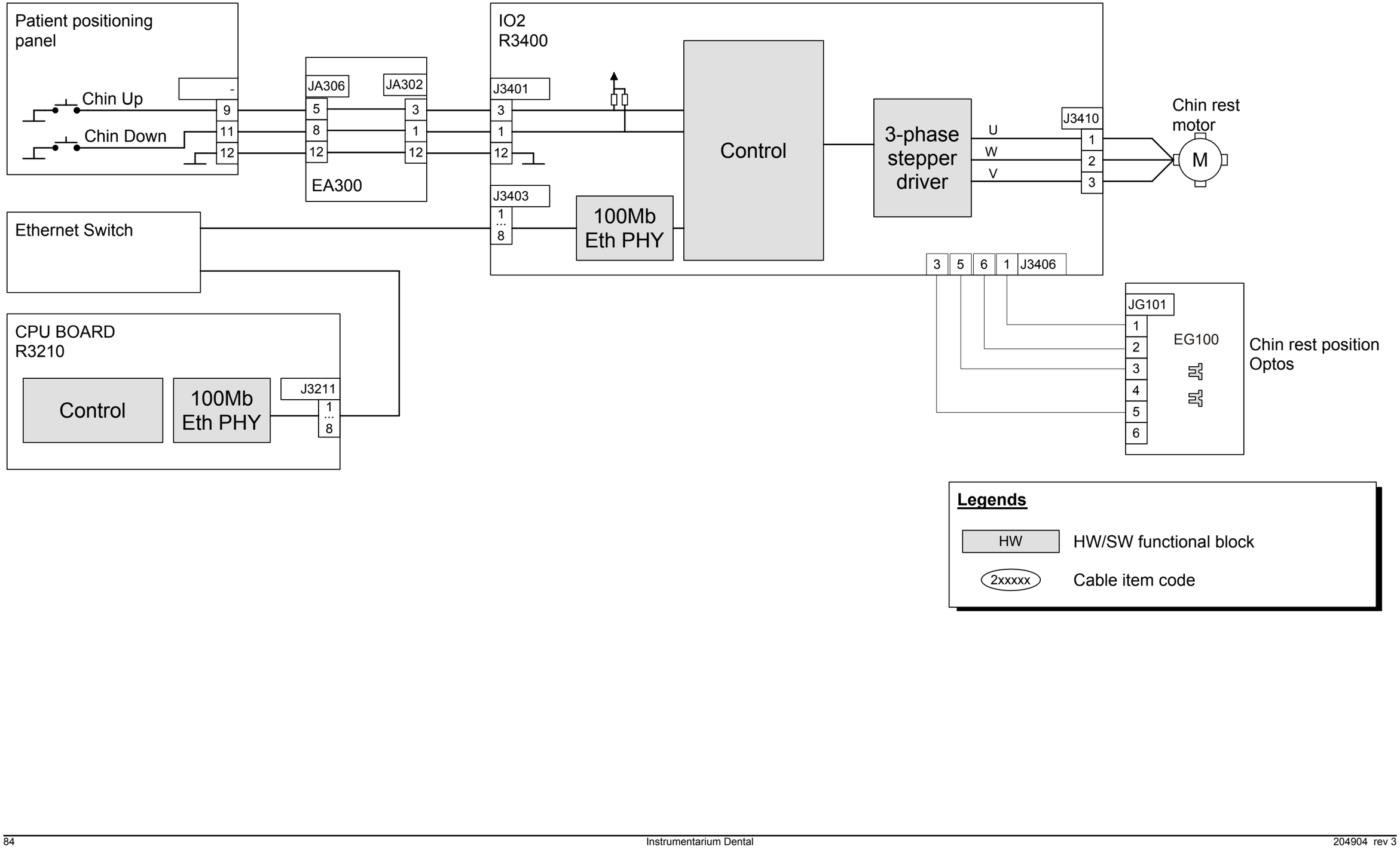
5.5 Y-movement



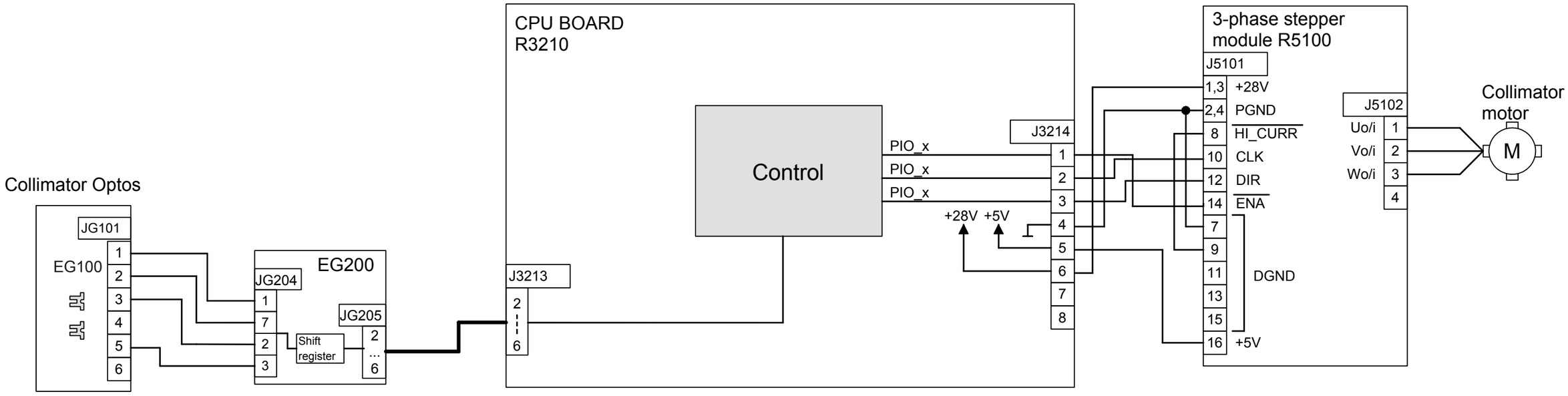
5.6 Z-movement



5.7 Chin rest movement



5.8 Collimator movement

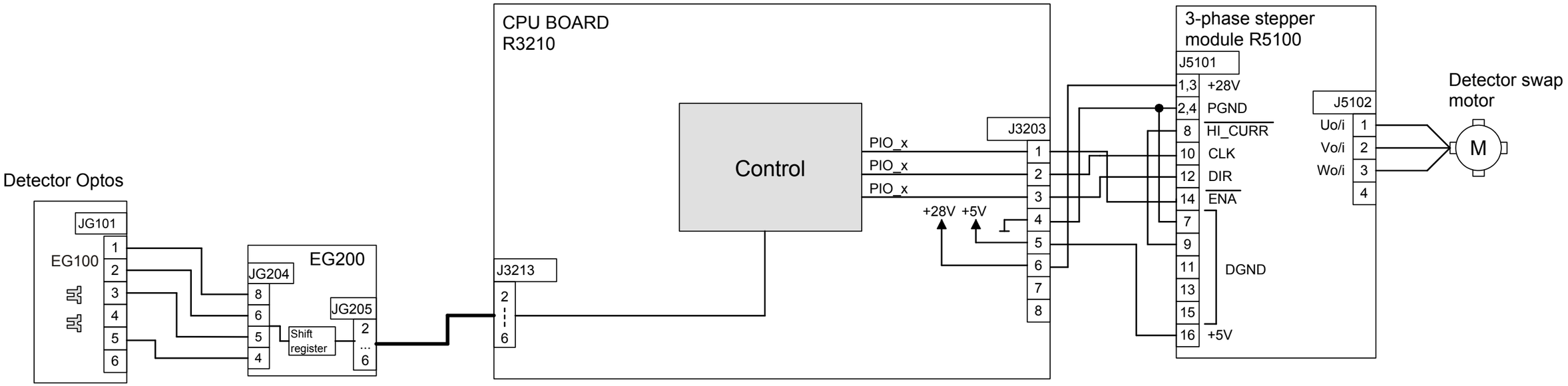


Legends

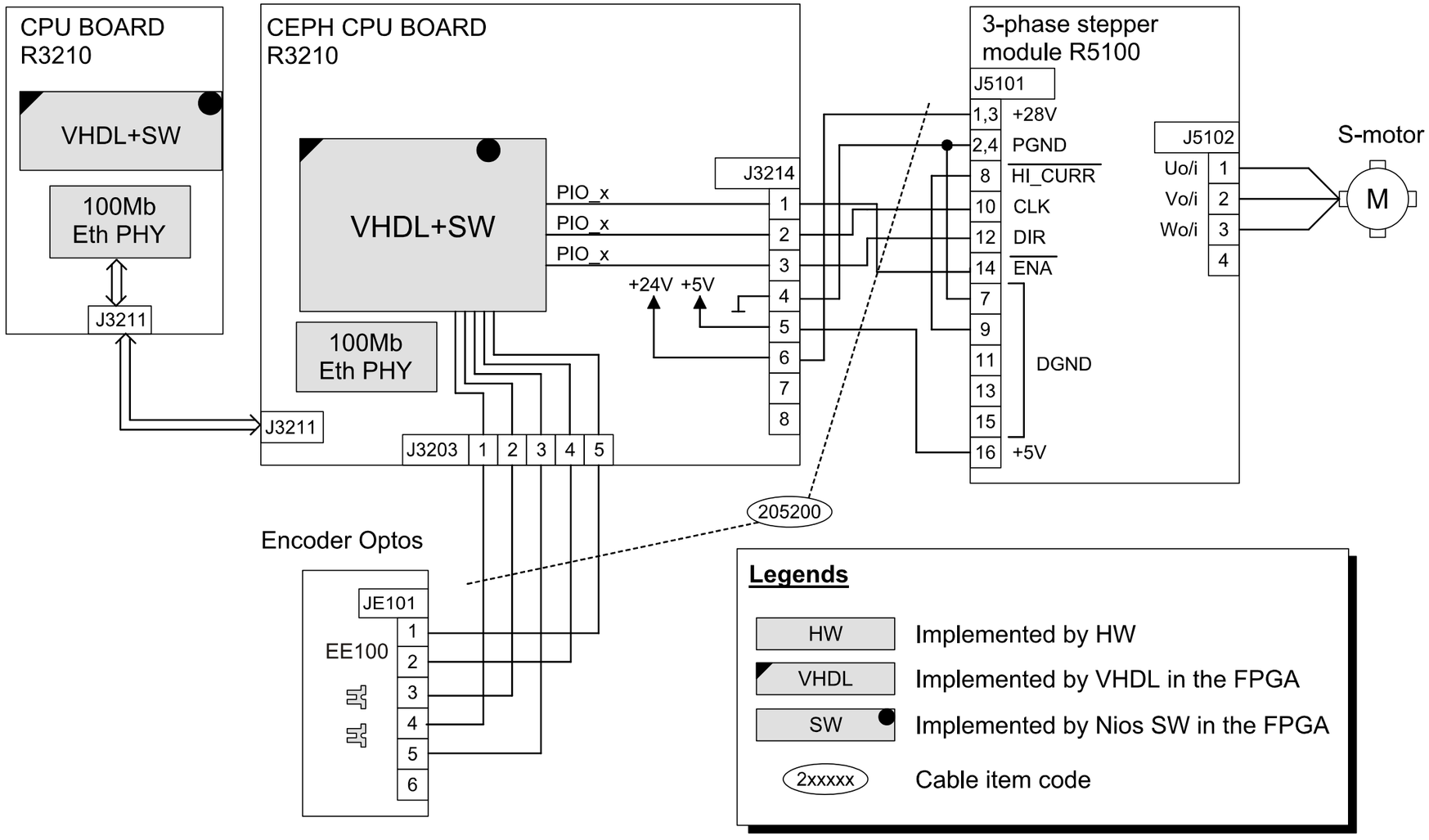
HW — HW/SW functional block

2xxxxx — Cable item code

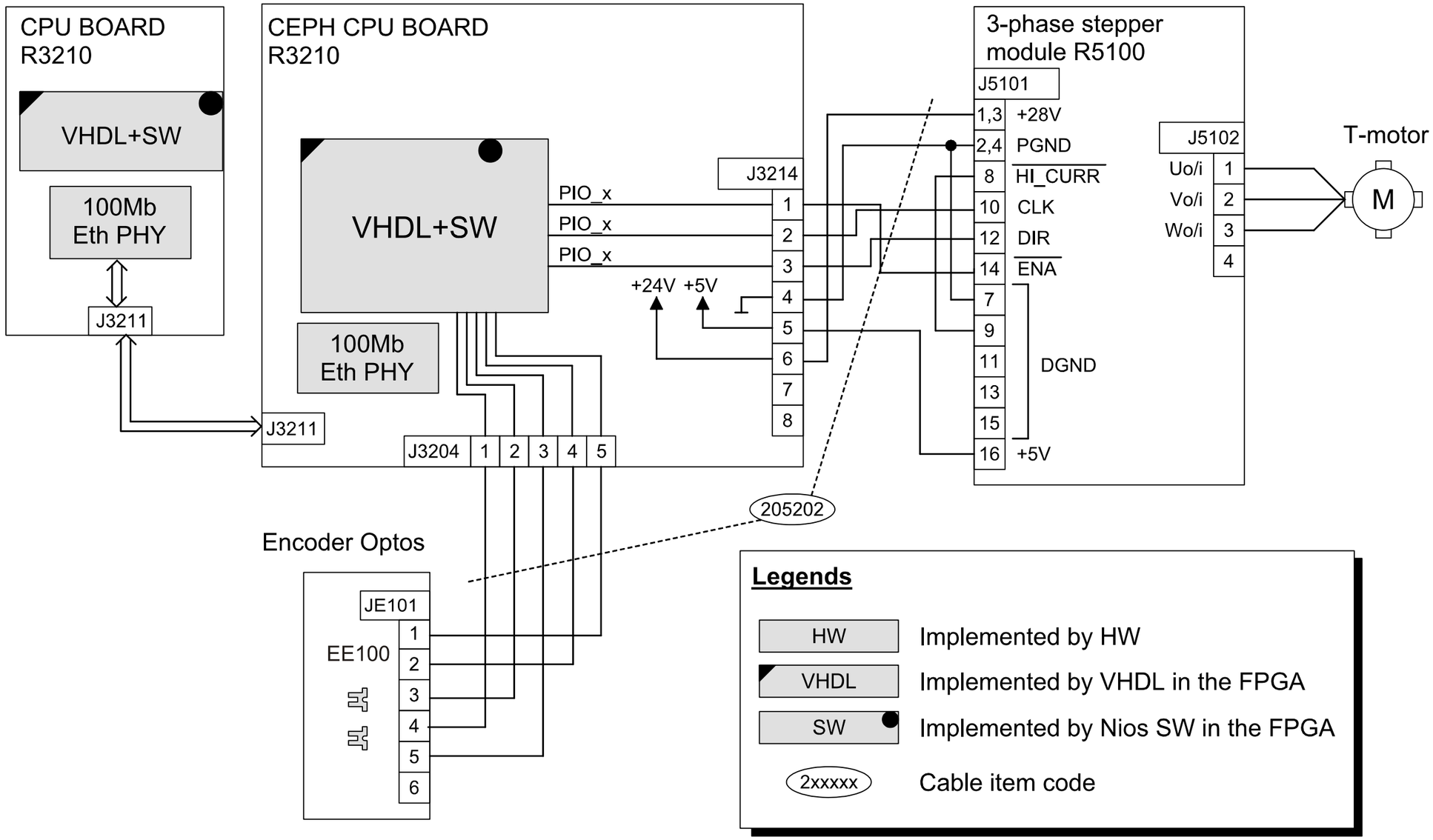
5.9 Pan sensor movement



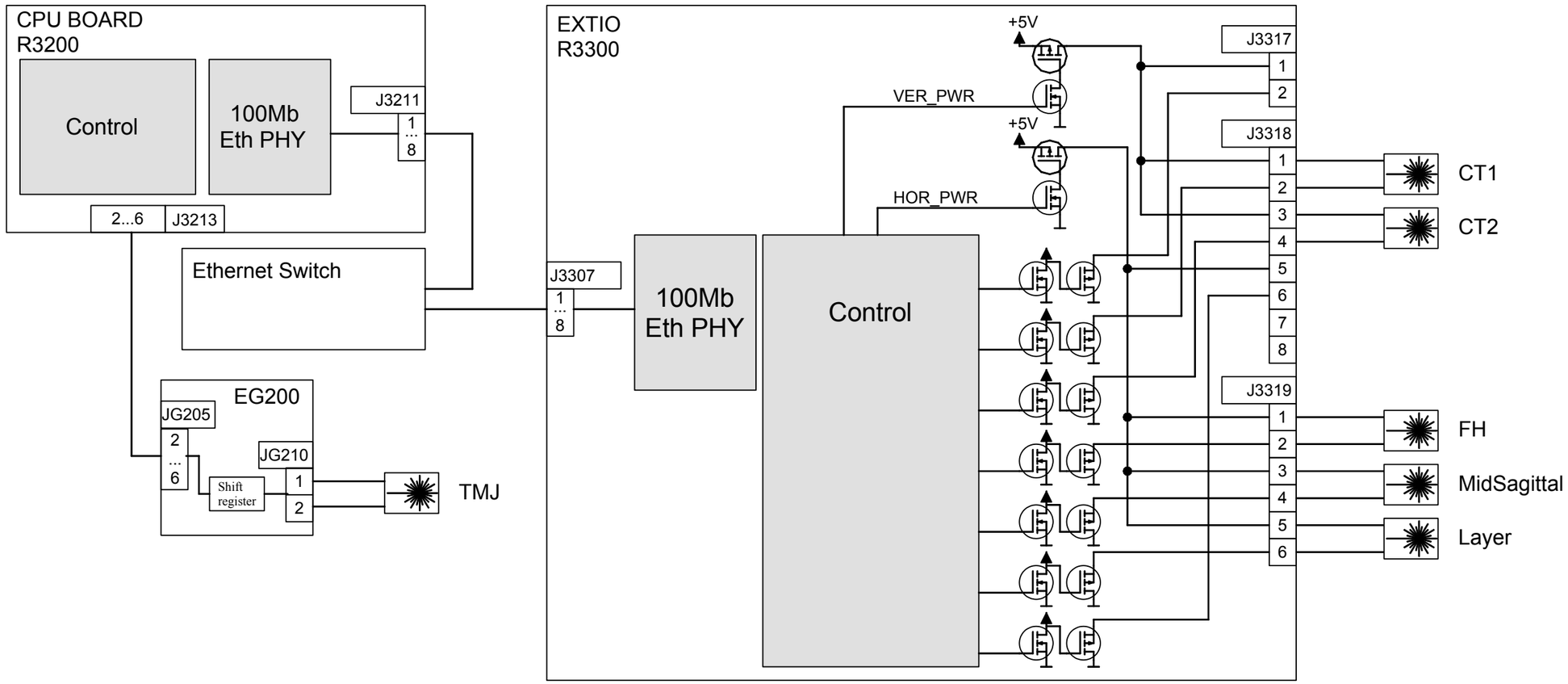
5.10 Secondary collimator movement



5.11 Ceph sensor movement



5.12 Positioning lights

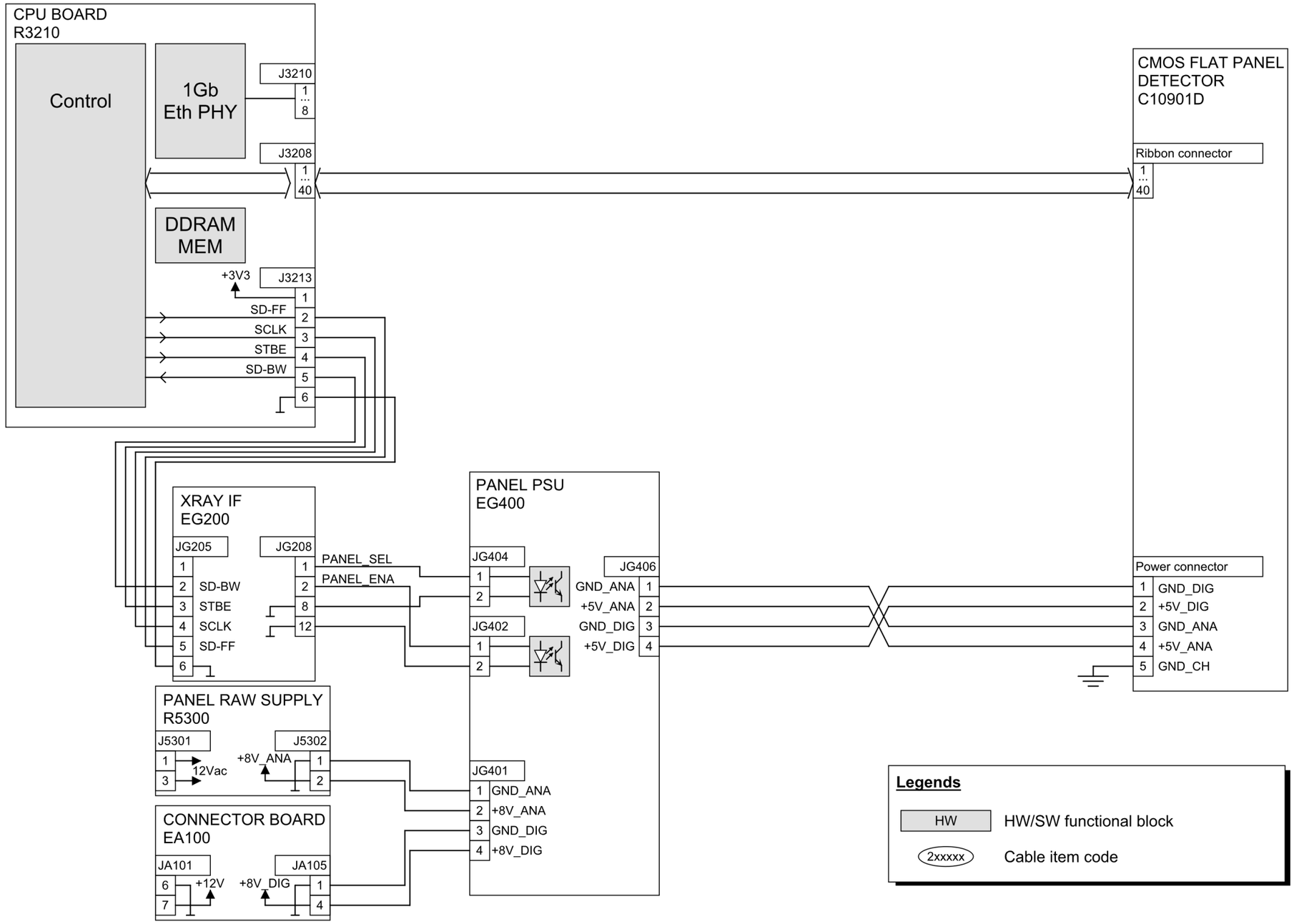


Legends

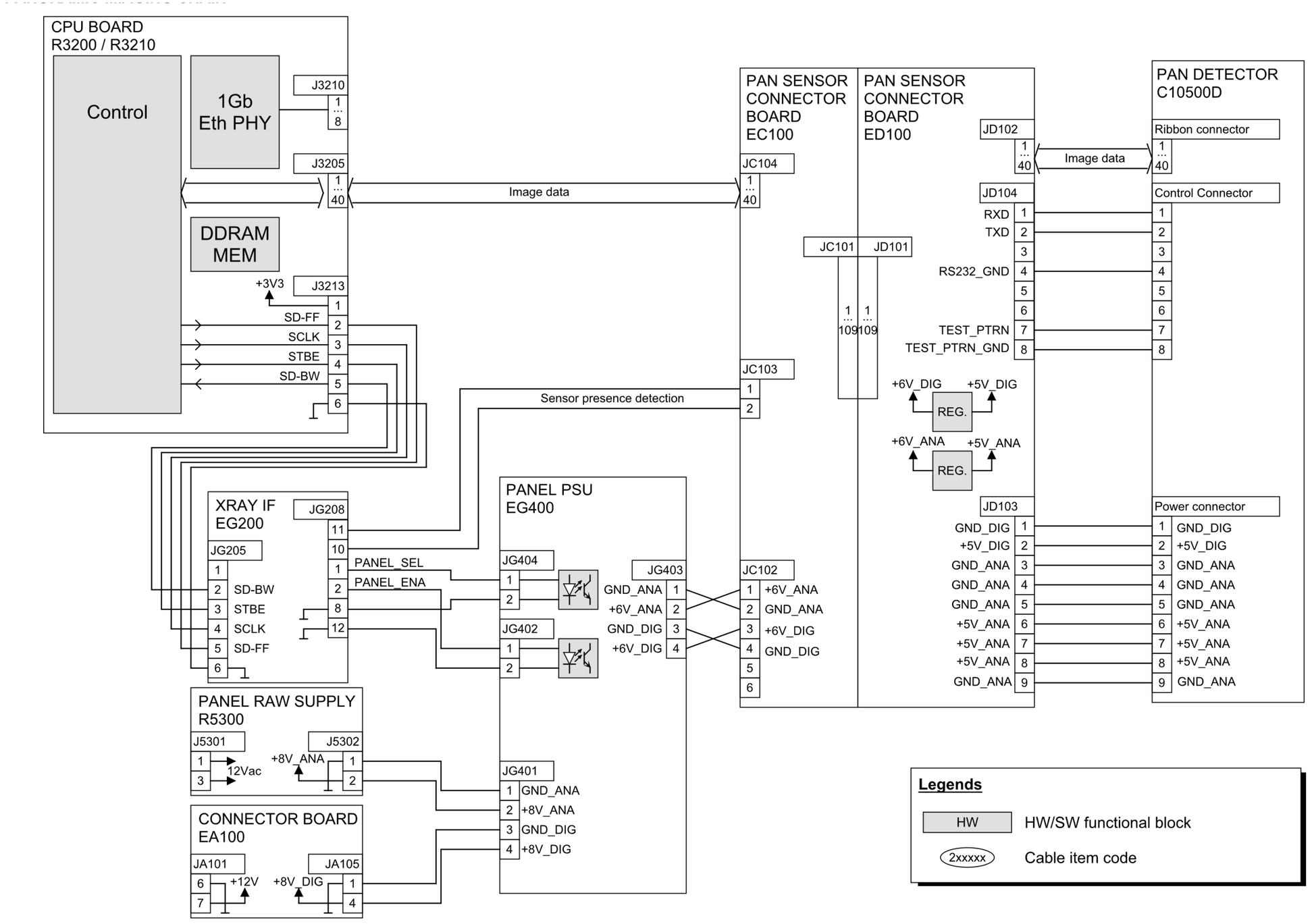
HW	HW/SW functional block
2xxxxx	Cable item code

5.13 Imaging chain

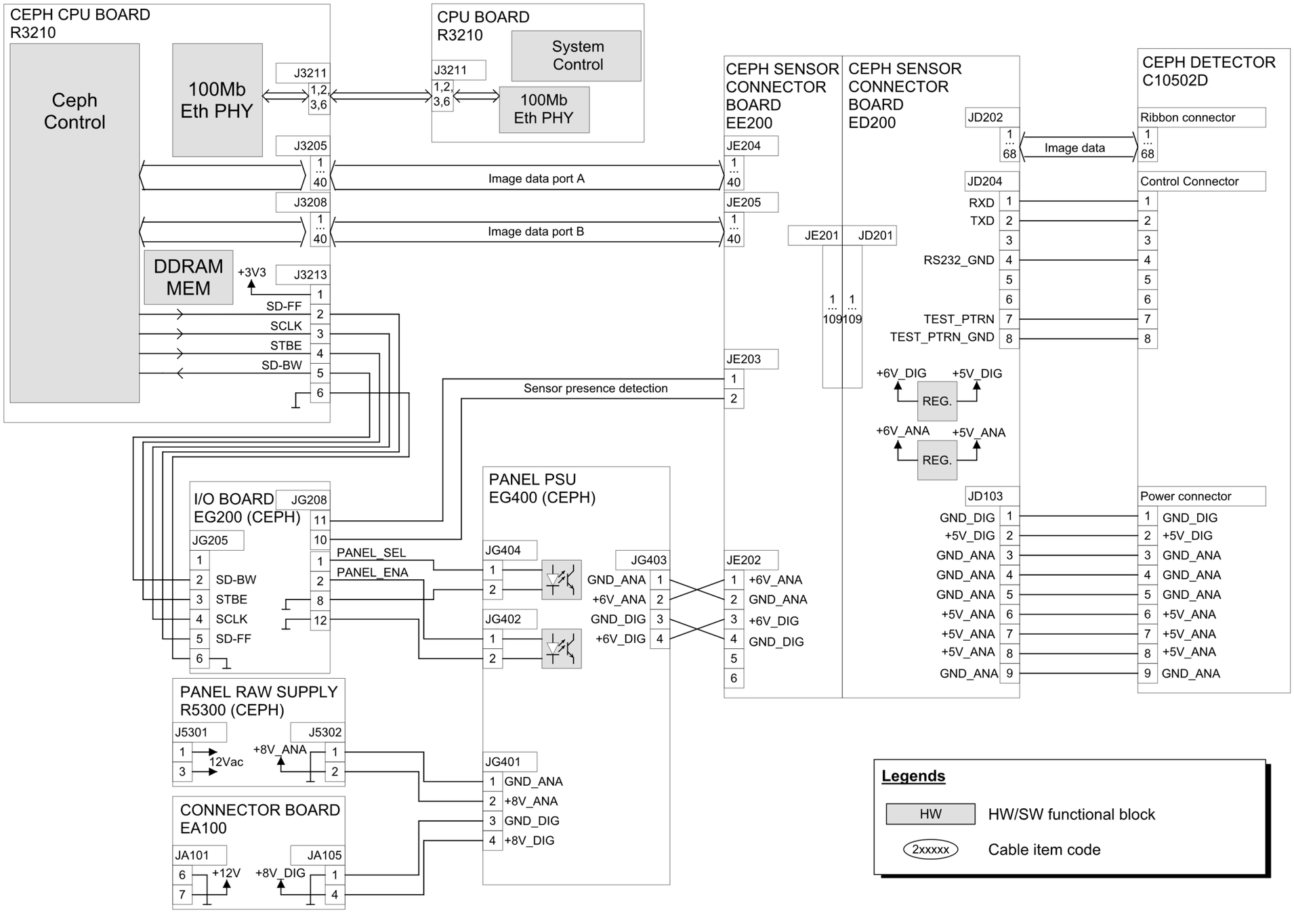
5.13.1 3D imaging chain



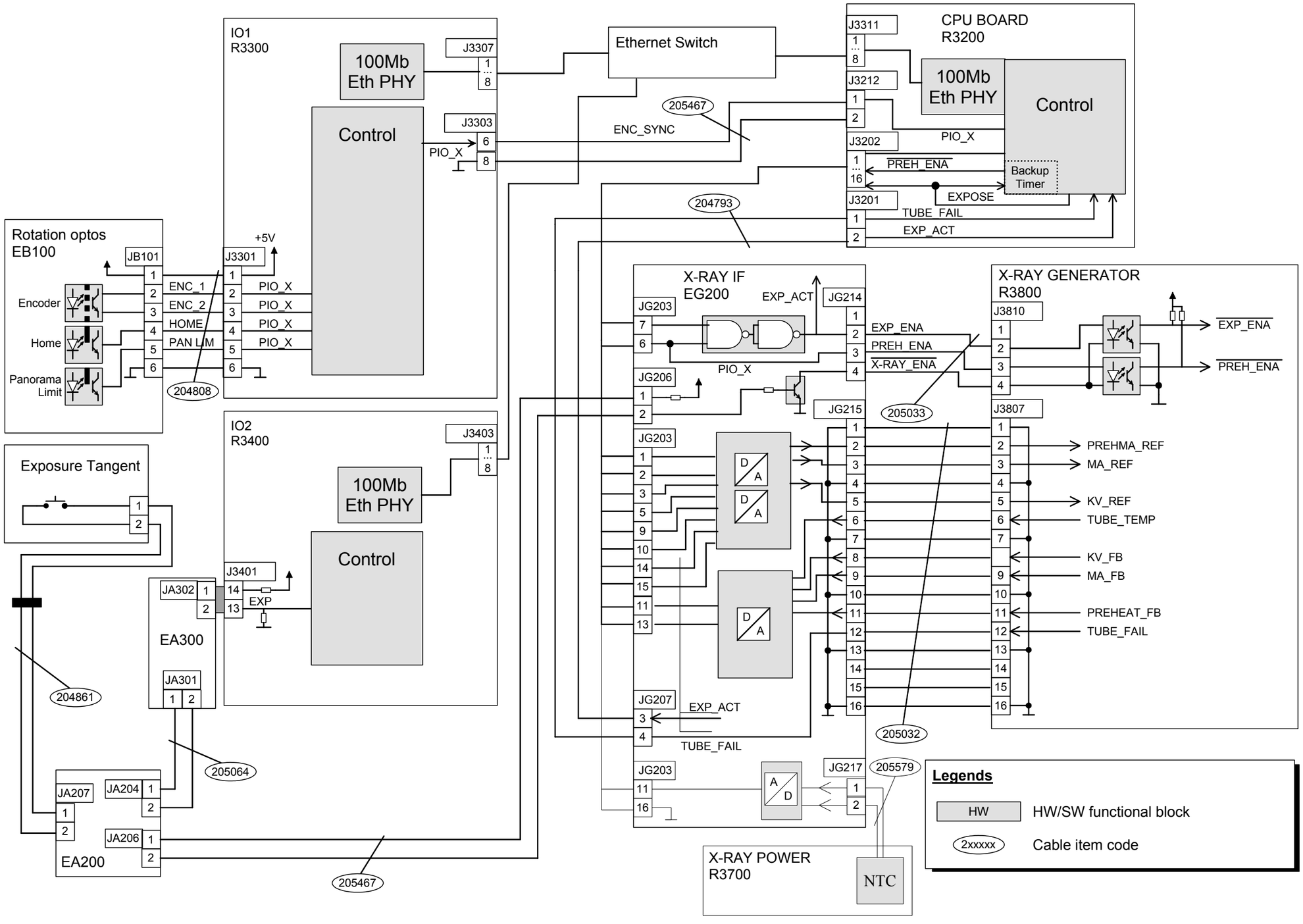
5.13.2 Panoramic imaging chain



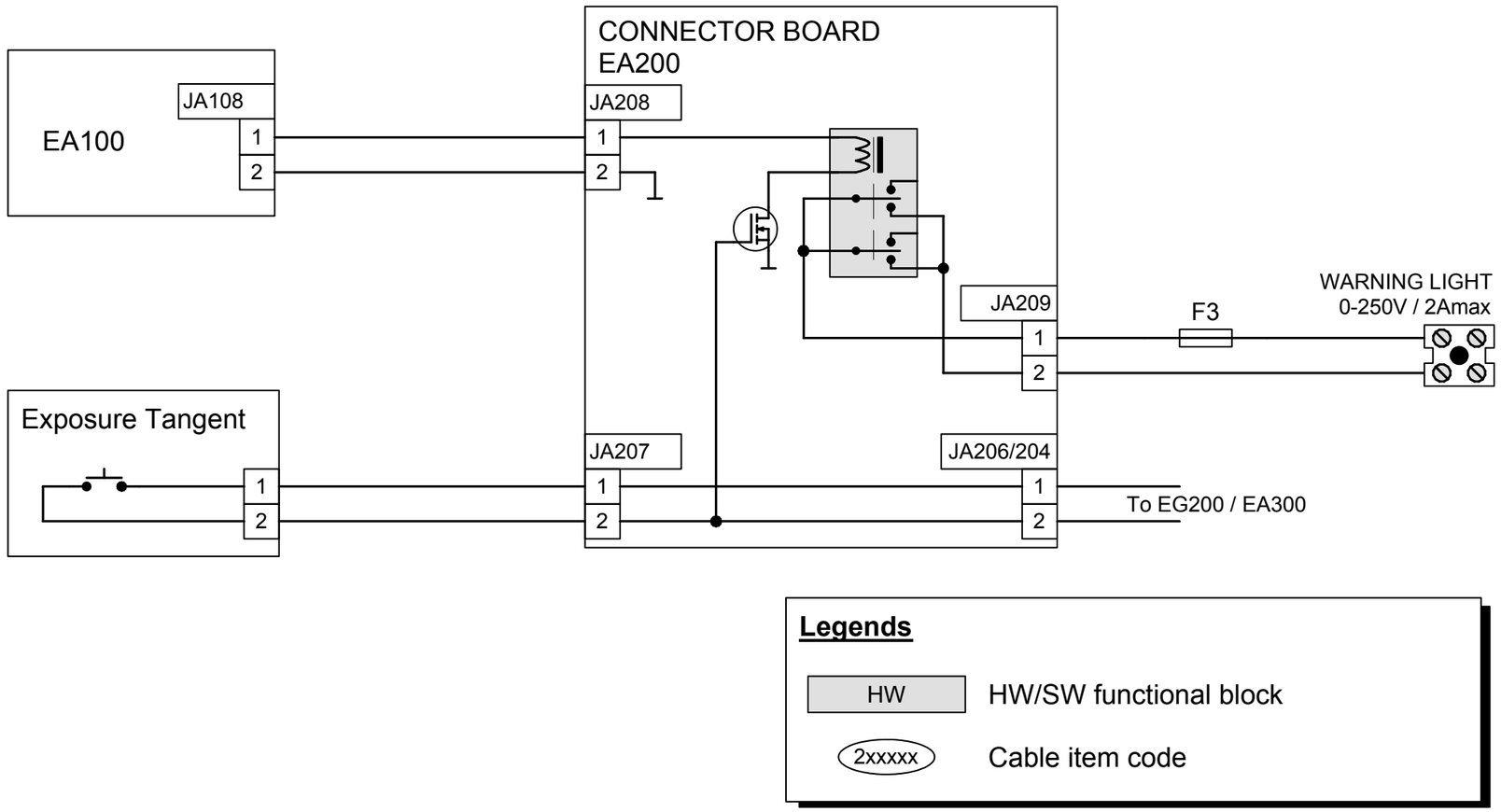
5.13.3 Cephalometric imaging chain



5.13.4 Exposure control



5.13.5 Exposure warning light



6 The s2terminal and service functions

The **s2terminal**, service terminal application, allows the operation of the unit to be checked, tested and configured and firmware to be upgraded.

There are three types of s2terminal commands:

- s2terminal commands, allow the s2terminal to download raw images and upgrade firmware

- unit state commands, allow the states of the unit to be check and changed.

- unit service commands, allow the function of the unit to be checked and configured.

Note! *The PC in which the s2terminal application is installed must be connected to the unit.*

6.1 Opening the s2Terminal

Opening the s2terminal from the release package

Copy the software release package to the host PC and unzip it. Locate openS2.bat in the unzipped release package and double click it. You will be prompted for unit's IP address. Type it in (if other than default) and press enter. An s2terminal connection is established to the unit.

Opening the s2terminal with the Command Prompt

1. Open the **Command Prompt** (**Start\Programs\Accessories**).

2. In the Command prompt key in **cd** and then path where the s2terminal application has been installed (e.g. **c:\program files\s2terminal**).

   ---
   cd c:\program fi les\s2terminal

   Press **ENTER**.

3. Key in **s2terminal** and then the **IP address** of the unit. Press **Settings** on the touch screen display. The IP address of the unit is shown in the settings window.

   ---
   cd c:\program fi les\s2terminal

   Press **ENTER** to open the s2terminal and make a connection to the unit.

   The s2terminal version number will appear together with a list of commands.

   ---- S2 Terminal Help ----------

xh	help
xi	receive image from the device
xr	reserve device
xq	quit

   Software and firmware version numbers will appear after the basic list of commands.

6.2 s2terminal commands

These commands allow images to be downloaded directly from the unit memory and the unit reserved if more than one client (an s2terminal or driver in the same PC or another PC) is connected to the unit. Additional commands (under help) allow firmware to be updated.

---- S2 Terminal Help ----------

xh	help
xi	receive image from the device
xr	reserve device
xq	quit

Downloading raw images - xi

1. Disable (no image capture) or close the dental imaging program in the PC(s) connected to the unit to ensure that the s2terminal has reserved the unit.
2. In the main **s2terminal** folder create a subfolder named **imageseries**.
3. Key in **xi** and press **ENTER**.
   The last image taken by the unit will be downloaded from the unit memory into the folder.

   Image will be saved in DCM (DICOM) format. The saved image can be opened with the dental imaging software or image viewers such as **ImageJ** or **IrfanView**.

Note! *If the unit was switched off after the last image was taken the image will be lost.*

Reserving the unit - xr

If you wish to take an image with the dental imaging software while the s2terminal is running you must release the s2terminal and reserve the dental imaging software.

1. Key in **xr** and then press **ENTER**.

---

xr

Mode NORMAL

The text **NORMAL** will appear which indicates that the s2terminal has released the unit so that the dental imagine software can be used to take an image when the image capture is activated.

2. After taking an image disable (no image capture) or close the dental imaging program and then press **xr** and then **ENTER**.

---

xr
Mode RESERVE

---

3. The text **RESERVE** will appear which indicates that the s2terminal is now active.

6.3 Unit state commands

The unit state commands, allow the states of the unit to be checked and changed.

Note! *Some of unit state commands can also be accessed when the unit is in service mode.*

status r

This command shows the current state of the unit.
The states are:

- **idle** state. The unit is ready to start an examination and is waiting for image capture, from the dental imaging software, to be activated (a message requesting this will appear on the touch screen display).

- **select** state. The imaging program and technique factors can be selected. When the **RETURN** key is pressed, to drive the rotating unit to the ready position, the unit will enter the next state, ready.

- **ready** state. The unit is ready to take an exposure. The text **READY** will appear on the touch screen display.

- **exposure** state. The unit will enter this state when the exposure switch is pressed and held down. The unit will enter the next state when the exposure button is released after the exposure is complete.

- **transfer_**check state. The image to being transferred from the unit to the PC. Note that image transfer already starts during exposure.

- **service** state. The unit is accepts the service commands.

- **error** state. The unit will enter this state if it malfunctions. An error message will appear on the unit touch screen display and the s2terminal if it is connected.

- **off** state indicates that firmware upgrades have been completed and the unit must be restarted for the upgrades to be activated.

cancel

Skips the current initialization phase, i.e. initialization of calibration data or initialization movements. This will allow the unit to go from state init to idle without all initialization being done.

Note! *This command can be used only for trouble shooting purposes. The unit will not be fully operational if all initializations are not done!*

patient

Changes the state of the unit from **idle** to **select** so that you do not have to activate image capture to start an examination.

service

Changes the state of the unit from **idle** or **error** to the service state so that the unit service commands can be accessed. (See section - Unit service commands)

reset

Changes the state of the unit from any state to the **init** state. This command reboots the firmware (not core) on R3210 CPU.

clients

Show how many client applications are connected to the unit, for example, the s2terminal and the dental imaging software.

login

Shows the firmware and core versions installed in the unit and the serial number of the unit.

6.4 Unit service commands

The unit service commands allow the operation of the unit to be checked and configured.

1. Key in **service** and press **ENTER**.

---

service

The unit enters and activates the service state.

Note! *The unit can only enter the service state from the idle or error states.*

2. Key in **help** and then press **ENTER**.

---

help

A list of unit service commands will appear.

---

calset	Forces the calibration programs to be marked as done or undone.
cephstatus	Displays status of all ceph optos, micro switches and encoders.
cephgetraw	Requests raw image frames from ceph CPU.
cancel	Bypasses initializations on startup.
cephimagingdir	Sets ceph imaging direction.
clients	Displays connected client applications.
conf	Displays configuration parameters.
copperthickness	Tells unit about changed copper thickness
counter	Displays the number of exposures taken.
dapcalib	Not currently available. Use command doserate instead
datatxdelay	Sets packet delay on image transfer.
demomode	Sets the unit to demonstration mode.
drivemotor	Drives the selected motor to desired position.
doserate	Configures doserate compensation
endstudy	If enabled, ends the patient study after exposure
help	Lists service commands/gives detailed help (help [command])
indicator	Sets or clears service/QA reminder messages or period.
ip	Configures the IP address of the external Ethernet interface.

log	Displays the log entries.
login	Displays unit's firmware version information
logsign	Adds a comment to the log
memtest	Performs a memory test on image memory area.
motortest	Runs a motor test.
patient	Starts fake study without using driver
posprint	Prints position information of selected motor.
panelpower	Sets the panel on/off.
readadc	Read adc channels
status	Displays unit's status information.
systemstatus	Displays status of all optos, micro switches and encoders.
unithandedness	Sets the unit's handedness.
vaccalib	Calibrates VAC value using real voltage value.

Note! *This list may vary from unit to unit.*

3. To open help instructions for a service command key in **help**, space, the name of the service command, for example **motortest**, and then press **ENTER**.

   ---

   help motortest

   Help instruction for that service command will appear.

   ---

   help motortest

   Usage: **motortest [rounds] [motor]**
   motortest [rounds]
   Drives all or specific motor from limit to limit.

   ---

4. To close the s2terminal key in **xq** and then press **ENTER**.

   ---

   xq

   ---

7 Error Codes and Trouble Shooting

7.1 Initial actions

Error Codes

When an error code appears on the display the unit will stop working and cannot be operated while the error code is on the display.

Acknowledging errors

The unit responds to error situations by reporting an error. Most errors may be acknowledged using the touch screen display (by closing the dialog box the error is reported in). Some errors require the unit to be rebooted. If such an error occurs, or if the unit fails to operate as described in the user's manual, switch the unit off, wait a few seconds and the switch the unit on again.

Image transfer

If an image is not transferred successfully to the PC, close and then reopen the dental imaging software and/or restart the PC.
DO NOT restart the unit as this will erase any image that is stored in the unit memory and this retrievable image will be lost.

7.2 Checking the unit

Diagnosing faults with the s2terminal

The s2terminal includes commands that allow the operation of the unit to be checked.

Unit service commands:

- **systemstatus**, allows the functionality of the optosensors, switches and micro switches to be checked.

- **drivemotor x** (x = the motor name), allows the operation of the different motors to be checked.

s2terminal command:

- Downloading raw images - xi, these images can be use for troubleshooting.

Refer to section, **The s2terminal and service functions**.

Checking circuit boards

Circuit boards cannot be repaired in the field. Some boards have fuses that can be replaced. However, if a board is faulty, replace it.

On most of the circuit boards there are indicator LEDs (D) and test pins (TP), that allow the operation of the board to be checked and/or tested. The LEDs and test pins for each circuit board are described in the section **Electrical Description**. Use a digital multimeter (DMM) when checking boards.

DANGER HIGH VOLTAGE:

R3400 IO2, R3700 X-ray power supply, R3800 X-ray generator and R3900 Mains connector include high voltage indicator lamps (Glim). When a high voltage lamp is on it indicates that high voltage is present. DO NOT touch the board until the high voltage has dissapated and the lamp has gone out.

When handling circuit boards take all necessary precautions to prevent the build up of static electricity and possible static damage to the boards.

Checking cables and connectors

Visually check cables for mechanical damage, cuts, damaged insulation and bad twists. If a cable is damaged in any way replace it.

If there is no obvious mechanical damage to a cable but you think that it may be faulty, use a digital multimeter (DMM) to check the resistance of the different wires within the cable. An undamaged wire will have close to no resistance (>0 ohm), a damaged wire will have a high resistance value.

Make sure that all cables are correctly and securely attached to their respective connectors. Connectors must not be loose or misaligned. If the connector has a locking mechanism make sure that it is locked.

If you fi nd a loose or misaligned connector, disconnect it and check for bent, broken or missing pins. If there is damage that can be easily repaired, for example straightening a bent pin, repair the damage and reconnect

the connector. If the damage cannot be repaired replace the cable.

Note! *If the connector on the corresponding board is also damaged, the board may also have to be replaced.*

7.3 Reporting problems to technical support

If you need to contact technical support, please gather the information listed below. This information is absolutely crucial for diagnosing the problem.

Type of problem	Needed type of information
Image quality	Problem description Exported example images Screen shot from the imaging app. Raw files Image acquisition driver logs s2terminal log
X-ray unit errors	Problem description s2terminal log Image acquisition driver logs GUI logs (if related to GUI) Video or photos if relevant
X-ray unit errors Calibration problems	Problem description s2terminal log Image acquisition driver logs Raw files Video or photos if relevant
Connectivity problems	Problem description s2terminal log Image acquisition driver logs
I'm not sure	Problem description s2terminal log Image acquisition driver logs Raw files GUI logs Video or photos if relevant

Problem Description

Describe the problem in as much detail as possible:

- Problem statement
- Unit serial number
- Unit software release number
- IAM version used in workstation (see Program and Features under Control Panel)
- Imaging software used

- What were you or the user doing when the problem occurred?
- Did the problem occur once or repeatedly? How often? At any special occasion?

Exported example images

Refer to the documentation of the imaging software used for instructions on how to export images. Preferred image formats are PNG or TIFF.

Raw files

The image acquisition driver can be configured to save the information it receives from the X-ray unit and uses for processing. For the raw files to be useful, saving must be enabled while the problem at hand occurs (must typically be repeated with saving enabled).

To enable saving of raw files, proceed as follows.

1. Close the imaging application. Make sure that the “CBCT driver” icon disappears from the taskbar.

2. Make a copy of C:\ProgramData\Dxr120\dxr120.xml for later reference.

3. Open C:\ProgramData\Dxr120\dxr120.xml using Notepad.

4. Locate a tag named <saveraw>0</saveraw>. Create it after <logl></logl> if it doesn’t exist. Change the tag value to 2. Save and close the file.

5. Raw files of images processed will be stored under the path C:\ProgramData\Dxr120\Raw.

To disable saving of raw files again, repeat the steps listed above, but change the tag value back to 0 or restore the original file. Leaving the value at 2 will fill up the hard disk drive of the workstation over time and makes image processing slightly slower.

Image acquisition driver logs

Image acquisition driver logs are located under C:\ProgramData\Dxr120\ and contain information related to transfer and processing. Zip all files located in this folder when reporting an image acquisition related problem.

S2terminal log

The S2terminal log contains information about what's going on in the X-ray unit and is only written when an s2terminal is connected to the X-ray unit in logging mode. The s2terminal log is most useful when the problem at hand is repeated while s2terminal logging is enabled. To create an s2terminal log, proceed as follows.

1. Start an s2terminal using openS2.bat from within a Embedded Software Release Package. Everything written to the s2terminal will now be logged to a file.

2. Put the terminal in NORMAL mode by typing in xr followed by enter.

3. Repeat the situation in which the problem occurs (if possible).

4. Collect additional unit information.

    4.1. Enter service mode using command service.

    4.2. View error history using command log.

    4.3. View unit configuration using command conf.

The log file written is found in the same folder as the s2terminal and is named s2t_10.208.6.101.log. The name is different if default unit IP address is not used.

GUI logs

GUI logs may be useful for troubleshooting GUI related problems. They may be downloaded from the GUI PC using the following steps.

1. Start an s2terminal using openS2.bat from within a Embedded Software Release Package.

2. Put the s2terminal is in reserved mode by typing xr followed by enter until the terminal replies "Mode RESERVED".

3. Download the logs using command xdl.

After download the GUI logs are located in a zip package named logs.zip in the s2terminal folder.

7.4 Error code descriptions

7.4.1 Error 4 Rotator home position was not found

CAUSE A Belt(s) slipping. The rotator is not rotating properly.

SOLUTION A Clean belt(s) and pulleys and adjust belt tension.

CAUSE B The home position is not detected by the rotator optos.

SOLUTION B Use the s2terminal service program “systemstatus” to check whether the home opto signal is reaching the main CPU. The home position of the rotator is the tubehead pointing away from the pillar. If the signal state is not changing when the opto switch is activated/deactivated, one of the following is faulty: JB101 Opto Board, R3300 IO board or cable 204816. Locate the faulty component using a multimeter and replace/repair faulty parts.

7.4.2 Error 5 Exposure was taking too long and a timeout occured

CAUSE A Main CPU board faulty.

SOLUTION A Replace the main CPU board.

CAUSE B An internal error has occurred.

SOLUTION B Update to the latest software version. Please notify technical support about the situation in which the error occurred.

7.4.3 Error 6 Generator failure

CAUSE A X-ray generation failed due to outdated calibration.

SOLUTION A Redo preheat and mA calibrations. Check that the result is valid (values not zero).

CAUSE B Reference signals are not reaching the X-ray generator (R3800) properly.

SOLUTION B Check that all cables between the R3210 main CPU and EG200 E-Ray IF board are properly connected (see schematic in 5.5 Exposure control). Replace cables and EG200 if needed.

CAUSE C Failure in X-ray generation. Replace the following parts one by one. Redo preheat and mA calibration after any component is changed.
- R3800 X-ray generator
- R3700 X-ray PSU
- Tubehead

7.4.4 Error 9 R3300 IO1 board is not functioning

CAUSE A Communication between the main CPU and R3300 is not working properly.

SOLUTION A
• The Ethernet cable between the R3300 and the internal Ethernet switch may be faulty. Try with a spare cable and replace the cable if needed.
• If also error 12 is shown, check the cable between the main CPU and the internal Ethernet switch. Try with a spare cable and replace the cable if needed.
• Check the internal Ethernet switch and replace if needed:

- Appropriate leds are lit: each port having a cable connected should have the link led on.
- The specified voltage level is present in power connector of the switch.

CAUSE B The R3300 IO board software is incompatible with the main CPU software. State commanded for beeper is not matching the feedback value.

SOLUTION B Update the software(s). Verify that the versions listed by the s2terminal command “login” match versions.txt in the software update package.

CAUSE C The R3300 IO board is faulty and therefore not responding.

SOLUTION C Replace the board.

7.4.5 Error 12 R3400 IO2 board is not functioning

CAUSE A Communication between the main CPU and R3400 is not working properly.

SOLUTION A
• The Ethernet cable between the R3400 and the internal Ethernet switch may be faulty. Try with a spare cable and replace the cable if needed.
• If also errors 9 is shown, check the cable between the main CPU and the internal Ethernet switch. Try with a spare cable and replace the cable if needed.
• Check the internal Ethernet switch and replace if needed:

- Appropriate leds are lit: each port having a cable connected should have the link led on.
- The specified voltage level is present in power connector of the switch.

CAUSE B The R3400 IO board software is incompatible with the main CPU software. State commanded for external warning light is not matching feedback value.

SOLUTION B Update the unit's embedded software. Verify that the versions listed by the s2terminal command "login" match versions.txt in the software update package.

CAUSE C The R3400 IO board is faulty and therefore not responding.

SOLUTION C Replace the board.

7.4.6 Error 13 Configuration data was lost

CAUSE A Main CPU flash memory corrupted.

SOLUTION A Recalibrate the unit. Replace the main CPU board if the problem reoccurs.

7.4.7 Error 21 Calibration data receive timeout

CAUSE A The main CPU did not receive calibration data from the GUI PC in time.

SOLUTION A
• Timeout due to communication problems. See Error 100 for hints on how to trouble shoot cables and Ethernet switch.
• Was the Cephalostat CPU recently replaced?
It may be loaded with invalid software for its purpose and therefore interfering with other communication. Update the Cephalostat CPU with proper software per instructions in pdf included in the embedded software release package.
• Did the GUI PC start normally (or is the screen dark and Error 21 reported in the s2terminal)?
If not, check that the GUI PC is powered properly. Replace the GUI PC if needed. Note that the unit then must be completely recalibrated. See 9 Calibration and adjustment for further instructions.

7.4.8 Error 22 Reading data from the 3D sensor failed

CAUSE A Bad contact in data cable connectors.

SOLUTION A
• Check the data cable (ribbon cable) is not damaged and that it is properly connected both to the 3D sensor and to the R3210 main CPU board (connector J3208). Reconnect or replace the cable if needed.
• Clean the connectors with flux remover. Let dry properly before reconnecting.

CAUSE B Voltage level out of range or voltage missing.

SOLUTION B Enable power for the 3D sensor using service command “panelpower conebeam 1”. Measure the digital voltage level from pin 1 and 2 on the sensor’s power connector. The allowed range is 4.9…5.1 V. If the voltage is missing, locate the point of failure with the help of the schematic in 5.4.1 3D imaging chain. Replace faulty parts.

CAUSE C Faulty 3D sensor

SOLUTION C Replace the 3D sensor and redo all 3D calibrations.

7.4.9 Error 23 Configuration data is invalid

CAUSE A Unit configuration data stored in the main CPU board is missing or corrupted.

SOLUTION A Recalibrate the unit. Replace the main CPU board if the problem reoccurs.

7.4.10 Error 24 Voltage (kV) failure in R3800 X-ray generator

The kV feedback signal from the generator is out of range. See also Error 6.

CAUSE A The exposure enable signal is not reaching the X-ray generator.

SOLUTION A Ensure that the exposure enable signal cable (205467) is properly connected to EA200/JA206 and EG200/JG206.

7.4.11 Error 25 Current (mA) failure in R3800 X-ray generator

The mA feedback signal from the generator is out of range. See also Error 6.

CAUSE A The exposure enable signal is not reaching the X-ray generator.

SOLUTION A Ensure that the exposure enable signal cable (205467) is properly connected to EA200/JA206 and EG200/JG206.

7.4.12 Error 26 Preheat failure in R3800 X-ray generator

The preheat feedback signal from the generator is out of range. See also Error 6.

CAUSE A The exposure enable signal is not reaching the X-ray generator.

SOLUTION A Ensure that the exposure enable signal cable (205467) is properly connected to EA200/JA206 and EG200/JG206.

7.4.13 Error 27 Rotation encoder failure

CAUSE A R3300 IO1 does not receive signals from EB100 Rotator opto board.

SOLUTION A
- Check that the cable between EB100 and R3300 is intact. Replace/repair the cable if needed.
- Replace the EB100 board.
- Replace the R3300 IO board.

7.4.14 Error 29 Error in sensor clocking signal

CAUSE A The error was reported as a side effect of Error 22 or Error 49.

SOLUTION A If the error was encountered during 3D imaging, see See Error 22. If the error was encountered during panoramic imaging, see Error 49.

CAUSE B Internal software error.

SOLUTION B Update the unit’s embedded software.

7.4.15 Error 30 CPU firmware is corrupted

CAUSE A The configuration flash memory is corrupted due to HW problems, a failure during programming, or the configuration being reset using service command “confreset all”.

SOLUTION A Update the unit’s embedded software. Replace the main CPU board if the error reoccurs.

7.4.16 Error 31 CPU board’s memory test failed

CAUSE A Faulty memory module(s).

SOLUTION A Replace main CPU memory module(s). Replace the main CPU board if the error reoccurs.

7.4.17 Error 33 Movement of C (collimator) motor failed

CAUSE A The collimator is not moving correctly.

SOLUTION A The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module or the
- cable between the stepper driver module and the CPU board.

In rare cases the Main CPU may also be faulty.
To check whether the motor is moving correctly, use service command “drivemotor c manual” and drive the collimator back and forth using the chin support up/down buttons. If the collimator is moving, the problem is probably in position detection (see CAUSE B). If the collimator is not moving, start with ruling out a Main CPU error. This can be done by connecting the collimator stepper driver cable (204791) to the N motor’s port in the main CPU board (J3204) and using service command “drivemotor n manual” and the chin rest up/down buttons to drive the collimator. If the collimator is moving when connected to the N motor port but not otherwise, there is a problem with the main CPU board. Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

CAUSE B Position detection showing incorrect values.

SOLUTION B Use service command “drivemotor c manual” and the chin support up/down buttons to drive the collimator past the positions where the opto switches are activated/deactivated. Check for messages in the s2terminal indicating the opto switches changing state. If no such messages are seen, there is a problem with the EG100 opto board or the cable between the opto board and the EG200 XRAY IF board.
If also motors D and N are failing, the serial IO data cable between EG200/J205 and R3210/J3213 may be faulty. Check the parts listed earlier and replace if needed.

7.4.18 Error 34 Movement of D (sensor) motor failed

CAUSE A The sensor is not rotating correctly.

SOLUTION A The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module or the
- cable between the stepper driver module and the CPU board.

In rare cases the Main CPU may also be faulty.
Use service command “drivemotor d manual” to test whether the motor is working properly. If the collimator is moving, the problem is probably in position detection (see CAUSE B). Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

CAUSE B Position detection showing incorrect values.

SOLUTION B Use service command “drivemotor d manual” and the chin support up/down buttons to drive past the positions where the opto/micro switches are activated/deactivated. Check for messages in the s2terminal indicating the switches changing state. If no such messages are seen, there is a problem with the EG100 opto board, the sensor position microswitch MSW2 or the cable between the switches and the EG200 XRAY IF board. If also motors C and N are failing, the serial IO data cable between EG200/J205 and R3210/J3213 may be faulty. Check the parts listed and replace if needed.

7.4.19 Error 35 Movement of J (chin support) motor failed

CAUSE A The chin support is not moving correctly.

SOLUTION A The movement not working correctly may be due to a fault in the
• motor,
• motor cable,
• R3400 IO board.
Use service command “drivemotor j manual” to test whether the motor is working properly. If the chin support is moving the problem is probably in position detection, see CAUSE B. Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

CAUSE B Position detection showing incorrect values.

SOLUTION B Use service command “drivemotor j manual” and the chin support up/down buttons to drive past the positions where the opto switches are activated/deactivated. Check for messages in the s2terminal indicating the switches changing state. If no such messages are seen, there is a problem with the EG100 opto board or the cable between the opto switch and the R3400 IO board. Check the parts listed and replace if needed.

7.4.20 Error 36 Movement of N motor failed

CAUSE A The rotator is not moving correctly in N direction.

SOLUTION A The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module or the
- cable between the stepper driver module and the CPU board.

In rare cases the port Main CPU may also be faulty. To check whether the motor is moving correctly, use service command “drivemotor n manual” and drive back and forth using the chin support up/down buttons. If the N movement is moving, the problem is probably in position detection (see CAUSE B). If no movement happens, start with ruling out a Main CPU error. This can be done by connecting the N motor stepper driver cable (204944) to the collimator motor’s port in the main CPU board (J3214) and using service command “drivemotor c manual” and the chin rest up/down buttons to drive the N motor. If the N movement is working when connected to the collimator motor port but not otherwise, there is a problem with the main CPU board. Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

7.4.21 Error 37 Movement of R (Rotation) motor failed

CAUSE A The rotator is not moving correctly.

SOLUTION A The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module,
- cable between the stepper driver module and the CPU board or the
- R3300 IO board.

Use service command “drivemotor r manual” to test whether the motor is working properly. If the chin support is moving, the problem is probably in position detection (see CAUSE B). Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

CAUSE B Position detection showing incorrect values.

SOLUTION B Check that cable 204808 is properly connected to Rotator opto board EB100. Reconnect or replace the cable and/or opto board if needed. The operation of two of the opto switches can be checked with service program “systemstatus” (signals “R outer opto” and “R inner opto”)

CAUSE C Faulty R3300 IO board.

SOLUTION C Replace the R3300 IO board.

7.4.22 Error 38 Movement of X motor failed

CAUSE A The X movement is not working correctly.

SOLUTION A The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module,
- cable between the stepper driver module and the R3300 IO board.

Use service command “drivemotor x manual” to test whether the motor is working properly. If the unit is moving in X direction, the problem is probably in position detection (CAUSE B). Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

CAUSE B Position detection showing incorrect values.

SOLUTION B Use service command “drivemotor x manual” and the chin support up/down buttons to drive past the positions where the opto switches are activated/deactivated. Check for messages in the s2terminal indicating the switches changing state. If no such messages are seen, there is a problem with the EG100 opto board or the cable between the opto switch and the R3300 IO board. Check the parts listed and replace if needed.

7.4.23 Error 39 Movement of Y motor failed

CAUSE A The Y movement is not working correctly.

SOLUTION A The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module,
- cable between the stepper driver module and the R3300 IO board.

Use service command “drivemotor y manual” to test whether the motor is working properly. If the unit is moving in Y direction, the problem is probably in position detection (see CAUSE B). Otherwise one of the components listed above is faulty. Continue with inspecting cables and connectors. Replace parts one by one if needed.

CAUSE B Position detection showing incorrect values.

SOLUTION B Use service command “drivemotor y manual” and the chin support up/down buttons to drive past the positions where the opto switches are activated/deactivated. Check for messages in the s2terminal indicating the switches changing state. If no such messages are seen, there is a problem with the EG100 opto board or the cable between the opto switch and the R3300 IO board. Check the parts listed and replace if needed.

7.4.24 Error 40 Movement of S (secondary collimator) motor failed

CAUSE A There is a problem with the S position detection.

SOLUTION A Use service program “cephstatus” to check the encoder status. Move the secondary collimator back and forth and verify that the encoder value changes. To resolve an encoder or opto switch error, check the cable between the opto board and the cephalostat CPU. Replace parts if needed.

CAUSE B The S movement is not working correctly.

SOLUTION B The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module,
- cable between the stepper driver module and the cephalostat CPU board.

Use service command “drivemotor s manual” to test whether the motor is working properly. Check for cables or other parts hindering the movement. Inspect cables and connectors, and replace parts one by one if needed.

7.4.25 Error 41 Movement of I (cephalostat sensor) motor failed

CAUSE A There is a problem with the T position detection.

SOLUTION A Use service program “cephstatus” to check the encoder status. Move the sensor back and forth and verify that the encoder value changes. To resolve an encoder or opto switch error, check the cable between the opto board and the cephalostat CPU. Replace parts if needed.

CAUSE B The S movement is not working correctly.

SOLUTION B The movement not working correctly may be due to a fault in the
- motor,
- motor cable,
- R5100 Stepper driver module,
- cable between the stepper driver module and the cephalostat CPU board.

Use service command “drivemotor s manual” to test whether the motor is working properly. Check for cables or other parts hindering the movement. Inspect cables and connectors, and replace parts one by one if needed.

7.4.26 Error 42 Ceph IO board is not functioning

CAUSE A The main CPU cannot communicate with the cephalostat CPU.

SOLUTION A
• Check proper connection of the

- Ethernet cable 205896 between the 10/100 Mb/s connector (J3211, not J3210!) of the ceph CPU and JE007.
- Ethernet cable 205036 between JE007 and the internal Ethernet switch.

Try connecting a spare cable between the cephalostat CPU and the internal Ethernet switch. Replace cables if needed.
• If also error 12 is shown, check the cable between the main CPU and the internal Ethernet switch. Try with a spare cable and replace the cable if needed.

• Check the internal Ethernet switch and replace if needed:

- Appropriate leds are lit: each port having a cable connected should have the link led on.
- The specified voltage level is present in power connector of the switch.

CAUSE B The cephalostat CPU is not powered properly.

SOLUTION B Check that leds are lit in the ceph CPU board, and that the voltage level between the black and red wire in connector J3206 is higher than 4.5 V. If the voltage is insufficient, check voltage levels in JG209 in the EG200 board and JA106 in the EA100 connector board (in the lower end of the pillar) to locate the point of failure. Replace faulty parts.

CAUSE C The cephalostat CPU's software is corrupted or invalid.

SOLUTION C Update / reprogram the cephalostat with new software. Update instructions are included in the software update package.

CAUSE D The cephalostat CPU is faulty.

SOLUTION D Replace the cephalostat CPU board.

7.4.27 Error 43 Serial IO board error

CAUSE A The EG200 XRAY IF board or the cable 204798 (between R3210 and EG200) is faulty.

SOLUTION A Check that the cable is properly connected. Replace the cable and/or the EG200 XRAY IF board.

7.4.28 Error 45 No X-rays detected on cephalostat sensor

CAUSE A The unit is not aligned properly.

SOLUTION A Redo the cephalometric calibrations.

7.4.29 Error 46 Emergency stop button is pressed

CAUSE A The emergency stop button is activated.

SOLUTION A Release emergency stop button and dismiss the error message. If the unit is equipped with a cephalostat, emergency may also be activated from the cephalostat.

CAUSE B The emergency stop switch is not working properly. The switch shall open the circuit when pressed and make a short circuit otherwise.

SOLUTION B Check the switch operation with a multimeter and replace if faulty. If the unit is equipped with a cephalostat, check also the emergency stop button located in the bottom of the cephalostat.

CAUSE C The loopback connector shorting the cephalostat emergency stop for non-ceph units is missing (shall be connected to JE006 in the top of the pillar).

SOLUTION C Attach the loopback connector, or if it's present, check that the emergency stop signal is passing through the connector properly.

CAUSE D Emergency stop switch cabling is faulty.

SOLUTION D Short the pins in JA303 and JA304 in the EA300 Extension board. If the error is no longer present, the cables are faulty and need to be repaired/replaced. If shorting the pins in the J304 removes the error, the problem is related to the cephalostat (cables, emergency switch, connectors). Check and repair/replace cables if needed.

CAUSE E EA300 extension board or R3400 IO board is faulty.

SOLUTION E If the error is still present with the pins in JA303 and JA304 shorted, the error is in the EA300 or R3400 board. Replace both boards.

7.4.30 Error 47 Button stuck

Error 47 Button stuck.

CAUSE A One or more buttons are stuck.

SOLUTION A Use service program “systemstatus” to determine which button is not reacting (is stuck) to being pressed. Replace keypad(s) if needed. Note that the button stuck may also be in the cephalostat.

7.4.31 Error 48 Internal failure

CAUSE A An internal failure has occurred.

SOLUTION A Update to the latest software version. Please notify technical support about the situation in which the error occurred.

7.4.32 Error 49 Reading panoramic sensor data failed

CAUSE A The sensor is not properly connected.

SOLUTION A Lift the lever at the side of the panoramic sensor, and firmly push it back.

CAUSE B The connection between the sensor and the sensor holder is bad.

SOLUTION B Power off the unit and clean the connectors in the sensor and sensor holder with flux remover. Make sure the connectors are dry before powering on again.

CAUSE C Voltage level out of range or voltage missing.

SOLUTION C Enable power for the panoramic sensor using service command “panelpower panoramic 1”. Measure the digital voltage level from pin 1 and 2 on the sensor’s power connector. The allowed range is 4.9…5.1 V. If the voltage is missing, locate the point of failure with the help of the schematic in 5.4.2 Panoramic imaging chain. Replace faulty parts.

CAUSE D Faulty / loose data cables or connector boards.

SOLUTION D Verify that all cables related to the panoramic imaging chain are intact and properly connected.

CAUSE E Faulty panoramic sensor.

SOLUTION E Replace the sensor and redo all panoramic calibrations.

7.4.33 Error 50 Reading cephalostat sensor data failed

CAUSE A The sensor is not properly connected.

SOLUTION A Lift the lever at the side of the cephalostat sensor, and firmly push it back.

CAUSE B The connection between the sensor and the sensor holder is bad.

SOLUTION B Power off the unit and clean the connectors in the sensor and sensor holder with flux remover. Make sure the connectors are dry before powering on again.

CAUSE C Voltage level out of range or voltage missing.

SOLUTION C Enable power for the panoramic sensor using service command “panelpower ceph 1”. Measure the digital voltage level from pin 1 and 2 on the sensor’s power connector. The allowed range is 4.9…5.1 V. If the voltage is missing, locate the point of failure with the help of the schematic in 5.4.3 Cephalometric imaging chain. Replace faulty parts.

CAUSE D Faulty / loose data cables or connector boards.

SOLUTION D Verify that all cables related to the panoramic imaging chain are intact and properly connected.

CAUSE E Faulty cephalometric sensor.

SOLUTION E Replace the sensor and redo all cephalometric calibrations (also redo panoramic calibrations if the sensor is used for both cephalometric and panoramic imaging).

7.4.34 Error 51 Cephalostat sensor missing

CAUSE A Cephalostat sensor removed during imaging.

SOLUTION A Reattach the sensor.

CAUSE B The sensor is not properly connected.

SOLUTION B Lift the lever at the side of the cephalostat sensor, and firmly push it back.

CAUSE C Faulty sensor detection

SOLUTION C Check that the cable attached to JE203 in the EE200 Connector board is properly connected. Re-connect/replace the cable if needed.

7.4.35 Error 100 Internal communication bus error

CAUSE A The GUI PC cannot communicate with the main CPU board.

SOLUTION A
• Check that the cable between the main CPU and internal Ethernet switch is properly connected and not damaged. Try with a spare cable. Replace the cable if needed.
• If also errors 9 and/or 12 are shown, check the cable between the main CPU and the internal Ethernet switch. Try with a spare cable. Replace the cable if needed.
• Check the internal Ethernet switch:

- Appropriate leds are lit: each port having a cable connected should have the link led on.
- The specified voltage level is present in power connector of the switch.

Replace the switch or power supply if faulty.
• Communication is failing due to the GUI PC being faulty; replace the GUI PC.

7.4.36 Error 101 Incorrect internal message format

CAUSE A GUI PC and main CPU software not compatible.

SOLUTION A Update the unit's embedded software. Verify that the versions listed by the s2terminal command "login" match versions.txt in the software update package.

7.5 Warnings and notifications

Please press any button to complete unit start up

CAUSE A The unit needs the operators acknowledgement to start initialization movements.

SOLUTION A Press any button on the patient positioning panel to start movement initialization. Wait for movements to complete.

Please wait for X-Ray tube to cool down

CAUSE A The X-ray tube needs to cool down before next exposure is started.

SOLUTION A Wait for the X-ray tube to cool down. If the cool down time is long (900 seconds), the cool down time is caused by a hardware protection mechanism. Power off the unit and let it cool down for 15 minutes. If the error still appears, check possible causes below.

CAUSE B Loose or faulty generator temperature feedback cables.

SOLUTION B Check that the following cables are intact and properly connected:
- 205032 between EG200/JG215 and R3800/ J3807.
- Tubehead filament and feedback signals cable connected to J3809 in R3800.

Reconnect or replace if needed.

CAUSE C Faulty EG200 XRAY IF board.

SOLUTION C Replace the EG200 XRAY IF board.

CAUSE D Faulty tubehead thermal switch or thermal switch connection.

SOLUTION D Replace the tubehead.

CAUSE E Generator temperature monitoring faulty or miscalibrated.

SOLUTION E Use service program “readadc” to determine whether the temperature is measured correctly.

- ADC value 111 corresponds to the maximum allowed temperature (75 deg Celsius). Lower ADC values indicate a incorrectly calibrated measurement. Adjust trimmer R66 in the EG200 XRAY IF board until approximately 200 is read as ADC value at room temperature.

- ADC value 255 indicates the temperature sensor (connected to EG200/JG217) being loose or broken. Check connection and replace the sensor if broken. The resistance in the sensor should be roughly 4.7 kOhm.

Generator temperature sensor is broken

CAUSE A The generator temperature sensor is broken or loose.

SOLUTION A Check that the generator temperature sensor is properly connected. The sensor is connected to JG217 in the EG200 X-RAY IF board and should have a resistance of about 4.7 kOhm at room temperature.

Service period has expired and unit need maintenance

CAUSE A The service reminder timer has expired (by default one year after last service).

SOLUTION A Carry out annual service as lined out in section 9 Maintenance Procedure. Mark service as done using the “indicator” s2terminal service command.

End user quality assurance is needed to retain image quality

CAUSE A The quality assurance timer has expired (by default 180 days after last 3D QA).

SOLUTION A Run 3D geometry calibration, 3D pixel calibration and 3D QC. Running the corresponding panoramic calibrations is also recommended.

Mains voltage is out of range

CAUSE A Too low or high mains voltage connected to the unit.

SOLUTION A Connect the unit to a power outlet with correct rating See section 3.11 Connecting the unit to the mains in the installation manual for further instructions.

CAUSE B Wrong voltage range is selected.

SOLUTION B Select correct voltage range by connecting the corresponding selection connector (jumper) to J1 in the EA200 board. The EA200 board is located in the lower end of the column. See section 3.11 Connecting the unit to the mains in the installation manual for further instructions.

CAUSE C Voltage measurement calibration is not properly performed.

SOLUTION C Calibrate the voltage measurement using s2terminal service command “vaccalib”.

CAUSE D The voltage measurement signal is not reaching the main CPU (through the R3400 IO board).

SOLUTION D Check the cable between EA200/JA213 and R3300/J3315. Replace the cable if needed.

CAUSE E The voltage selection signal is not reaching the main CPU (through the R3300 IO board).

SOLUTION E Open up a connection to the X-ray unit using the s2terminal. Reboot the unit and check for a messages indicating the voltage range not being detected properly. Check that the voltage range detection cable is properly connected between EA200/J212 and R3300/J3418. Replace the cable if needed.

The unit is not fully calibrated for the selected program

CAUSE A One or more calibrations needed by the selected program are not competed.

SOLUTION A Switch to the service / quality assurance view in the GUI to find out which calibration is not done. Complete all calibrations marked as not done. Note that this message is not shown if there is a s2terminal connected to the X-ray unit.

Attach the panoramic sensor

CAUSE A Panoramic sensor not attached.

SOLUTION A Attach the panoramic sensor. Push down the lever on the sensor side to attach is properly.

CAUSE B Faulty sensor detection.

SOLUTION B Check that the cable attached to JC103 in the EC100 Connector board is properly connected. Reconnect/replace the cable if needed.

Attach the ceph sensor

CAUSE A Cephalostat sensor not attached.

SOLUTION A Attach the cephalostat sensor. Push down the lever on the sensor side to attach is properly.

CAUSE B Faulty sensor detection.

SOLUTION B Check that the cable attached to JE203 in the EE200 Connector board is properly connected. Reconnect/replace the cable if needed.

Exposure button was released during imaging

See also: Exposure button is pressed

CAUSE A The exposure was interrupted due to the exposure button being released.

SOLUTION A Check if the diagnostic value of the resulting image is sufficient. Take another image if needed.

Exposure button is pressed

CAUSE A The exposure button is pressed after imaging has ended or during startup.

SOLUTION A Release the exposure button.

CAUSE B Exposure button in stuck down, shorted or broken.

SOLUTION B Check the exposure switch with a multimeter, replace if faulty.

CAUSE C Faulty cable between EA300 Extension board (JA301) and EA200 Connector board (JA204).

SOLUTION C Check the cabling. Replace if needed.

CAUSE D Faulty EA200 Connector board, EA300 extension board or R3400 IO board.

SOLUTION D Try to locate the failing board using a multimeter. Replace faulty board(s).

Nasion support is in wrong position

CAUSE A The cephalostat nasion support (ear holders) is not rotated correctly for the selected imaging program.

SOLUTION A Rotate the nasion support into correct position.

CAUSE B The nasion support position detection is not detected correctly by the cephalostat CPU.

SOLUTION B Check that the position detection micro switch is activated / deactivated properly when the nasion support is rotated. Check the cable between the micro switch and EG200/JG204. Check the serial data line between EG200/JG205 and R3210/ J3213. Replace micro switch, cables or EG200 if needed.

Image processing error notifications

CAUSE A The image was not transferred to the PC correctly, or processing failed.

SOLUTION A If the current exam was closed, open a new exam for the same patient in the image acquisition workstation. Press the “Retrieve last image” button in the GUI to have the image re-transferred.

All needed calibrations are not yet done

CAUSE A One or more calibrations must be completed before imaging is allowed for all modalities.

SOLUTION A Switch to the service / quality assurance view in the GUI to find out which calibration is not done. Complete all calibrations marked as not done.

The sensor was moved from its correct position

CAUSE A The sensor was moved (rotated) out of position during exposure.

SOLUTION A Check if the diagnostic value of the resulting image is sufficient. Take another image if needed.

7.6 Hardware trouble shooting

7.6.1 Internal and external LANs

7.6.1.1 No Ethernet connection between the unit and the workstation

- See if the problem can be resolved by restarting the X-ray unit and the workstation.
- Check for problems in the workstation.

Try to set up a connection between the X-ray unit and the workstation using the s2terminal.
If a connection is established, check the installation and configuration of the image acquisition driver software.

Try to set up a connection between the X-ray unit and another PC (for example service laptop) using the s2terminal. If a connection can be established the problem is with the workstation.

Check that the “link” light, normally located next to the workstation’s network connector, is on when the cable is attached. If it is not on, the network card may be faulty. Check if the light is on when the service laptop is connected, this confirms whether the network card is faulty or not.

- Check for problems in network cables.

Replace the network cable between the X-ray unit and the workstation with an Ethernet cable (CAT5e or CAT6) known to be working.
If a connection is established, replace the original cable.

Connect the known to be working Ethernet cable between the workstation and connector JB004 in the upper part of the column. If a connection is established, replace the energy chain cables located behind the column.

Connect the known to be working Ethernet cable between the workstation and connector J3210 on the R3210 Main CPU board. If a connection is established, replace the whole main cabling in the rotating unit.

- Check for problems related to the R3210 Main CPU.

Measure the input voltage to the R3210 (min 4.5 V). If the voltage is OK, then replace the R3210 main CPU board. Otherwise refer to the instructions for power distribution trouble shooting.

7.6.1.2 Connection between the workstation and X-ray unit is lost from time to time

- Check for problems related to the R3210 Main CPU.

Measure the input voltage to the R3210 (min 4.5 V). If the voltage is missing or too low, see the instructions for power distribution trouble shooting.

- Check for problems related to network cables as described in previous section, but take a few exposures and check for problems before proceeding to next step.

7.6.1.3 No connection to R3300, R3400 and GUI PC (internal bus failure)

- Switch the X-ray unit on and check that R3300, R3400 and the internal Ethernet switch are receiving power (see trouble shooting of the power distribution, chapter 7.6.3.7.).
- See Error 100 in the error code description section.

7.6.1.4 No connection to the R3300

- Switch power on to the X-ray unit and check that R3300 and the Ethernet switch are receiving power (see trouble shooting about power distribution).
- See Error 9 in the error code description section.

7.6.1.5 No connections to the R3400

- Switch power on to the X-ray unit and check that R3400 and the Ethernet switch are receiving power (see trouble shooting about power distribution).
- See Error 12 in the error code description section.

7.6.2 Power distribution (mains)

7.6.2.1 Nothing happens when the X-ray unit is switched on

- Check that the mains cord is connected to the wall socket.

If not, plug it in.

- Check that there is mains power reaching the wall socket.

If not, call your local electrician to fix the problem.

- Check Fuses F1 and F2.

Check that correct voltage range is selected by checking the position of the voltage selector jumper J1 on the EA200 board.

Replace blown fuses.

- Open the front cover at the lower end of the carriage and check that the voltage indicator lamp on EA200 is on (or measure voltage from connector JA203).

If EA200 is receiving voltage then measure the secondary voltages from the low power supply.

⇒ If any of voltages are missing when each of the low voltage connectors are un-plugged, replace transformer.

⇒ If voltages are OK, when each low voltage connector is un-plugged, but not OK when any of connectors is connected, then follow trouble shooting for the LOW voltage side.

7.6.2.2 No X-rays

- Check that lamp (LA1) on R3700 (generator power) is on.

If not then check that voltages exist on input of the generator filter.

⇒ If not, replace mains cabling.

⇒ If voltages exist, replace filter.

If the lamp is on check lamp (LA1) on R3800 (X-ray generator).

⇒ If not on, check fuses on R3700 and replace them if blown. If fuses not blown, check cabling between J3703 and J3802.

⇒ If on, follow trouble shooting guide for Exposure control in chapter 7.6.6.

7.6.3 Power distribution (low voltages)

The low power is generated by a mains transformer and a MPQ-200 switching power supply. The low voltage from the transformer is used to generate analog voltage for the sensors. Other low voltages are generated by the MPQ-200 switching power supply.

Malfunctioning sections in the power and distribution chains can be located by checking the LEDs at the end of each branch and then reverse measuring the voltages further back down the path towards the power supply.

To localize overload malfunction is little more difficult as the switching supply is overload protected and an over current in any branch will cut whole supply to off (see chapter 7.6.3.1.).

7.6.3.1 Nothing happens when the X-ray unit is switched on

- Check that all the LEDs on the EA100 are on.

If not, check fuses on the EA100.

⇒ If any of the fuses are blown, replace them.

⇒ If the fuses are OK then unplug connectors JA102-106 one by one and check that the LEDs are on.

⇒⇒ If not, replace EA100.

⇒⇒⇒ If after replacing EA100 the LEDs still do not come on, replace the low power supply.

⇒⇒ If LEDs are on after un-plugging some of the connectors, then follow the power distribution chain in question by cutting it step-by-step until the LED in question goes out. Replace the next component (cable or board).

If each LED on EA100 is on then check the LEDs at the end of each power chain (see block diagram)

⇒ If some LED are not on, localize the failure as described above in “introduction”

⇒ If the LEDs are on replace R3210 main CPU board

7.6.3.2 X-, Y- or rotator not working

- Check +5V and +24V voltage indicators on the stepper modules.

If both indicators are on, follow the motion control trouble shooting guide.

If +5V indicator LED is not on but R3300 is active, replace the cable between stepper module (J5101) and R3300.

⇒ If LED still does not come on, replace R5100

If +24V indicator LED is not on, check that +24V indicator LED on the EA100 is on.

⇒ If not, see trouble shooting instructions in chapter 7.6.3.1.

⇒ If indicator is on, measure +24V voltage from J3309.

⇒⇒ Replace cable between J3309 and JA106 if there is no voltage.

⇒ If indicator is on, measure +24V voltage from J3311, J3313 or J3314.

⇒⇒ Replace R3300 if there is no voltage.

⇒ If indicator is on, measure +24V voltage from J5101.

⇒⇒ Replace cable between J5101 and R3300 if there is no voltage.

7.6.3.3 N-, Collimator- or sensor swap not working

- Check +5V and +24V voltage indicators of stepper modules

If both indicators are on then follow motion control trouble shooting guide.

If +5V indicator LED is not on but R3210 is active, replace cable between stepper module (J5101) and the R3200.

⇒ If indicator LED still does not come on, replace R5100.

If +24V indicator LED is not on, check that +24V_SD (D9) indicator LED on the R3210 is on.

⇒ If +24V_SD indicator is not on, check that +24V indicator LED on the EG200 is on.

⇒⇒ If +24V indicator LED on EG200 is not on check that +24V indicator LED on EA100 is on.

⇒⇒⇒ If not on, see chapter 7.6.3.1.

⇒⇒⇒ If on, see description in the introduction above.

⇒⇒ If 24V indicator LED on the EG200 is on, replace cable between J3206 and JG211.

⇒ If +24V_SD indicator LED is on, replace cable or R5100.

7.6.3.4 CEPH sensor or secondary collimator not working

- Follow instructions in chapter 7.6.3.3.

7.6.3.5 The panorama imaging not working

- Switch the X-ray unit ON, select the service mode from the s2Terminal and type the command **panelpower Panoramic 1** to switch pan sensor power ON: Check all the LEDs on EG400.

If all the LEDs are on, measure 2x +6V voltages from JC101 (sensor docking connector).

⇒ If each voltage are is OK then replace R3210.

⇒ If some of voltages are not present, replace EC100 and/or cable between JG403 and JC102.

If all LEDs are on and all the voltages are OK and R3210 has been replaced.

⇒ Measure voltage from JG406 (CT-power feed).

⇒⇒ If voltage is present, replace EG400.

⇒⇒ If not, replace PAN sensor.

⇒ If non or some of the LED's are on, follow the trouble shooting instructions above.

7.6.3.6 The 3D imaging not working

- Switch the X-ray unit ON, select the service mode from the s2Terminal and type command **panelpower Conebeam 1** to switch CT sensor power ON. Check the LEDs on the EG400.

If all LEDs are on, measure 2x +6V voltages from the sensor power connector.

⇒ If each voltage is OK then replace R3210.

⇒ If some of voltages are not present, replace EG400 and/ or cable between JG406 and the sensor power connector.

If all the LEDs are on and the voltages are OK and R3210 has been replaced.

⇒ Measure voltage from JG403 (PAN-power feed).

⇒⇒ If voltages are present, replace EG400.

⇒⇒ If not, replace CT sensor.

If non or some of LEDs are on, follow the trouble shooting instructions above.

7.6.3.7 The CEPH imaging not working

- Follow instructions in section 7.6.3.5 but follow CEPH power chain and select **panelpower Ceph 1** command from s2terminal.

7.6.3.8 R3210, R3300 or R3400 does not operate

- Check each voltage indicator LED on the board (see the Service Manual).

If any of the indicator LEDs are not on, replace the board.

7.6.4 3D imaging

7.6.4.1 3D sensor is not recognized

- Check the condition of the power feed by following trouble shooting guide 7.6.3.6 for 3D imaging not working.
- Replace LVDS data cable from J3208 to the CT-sensor and reboot the X-ray unit.

If 3D sensor is recognized, cable was faulty.

If it is not recognized, replace R3210 and reboot.

⇒ R3210 was faulty if the sensor is now recognized.

⇒ If sensor is still not recognized, replace the sensor.

7.6.4.2 Generally poor image quality

- Recalibrate the unit.
- Check condition of the power feed by following trouble shooting guide 7.6.3.6 for 3D imaging not working.
- Follow instructions in guide 7.6.4.1 to localize malfunctioning component. Replace components one by one and take 3D images of a suitable phantom.

7.6.4.3 Horizontal bars in projection image

- Check grounding cables near sensor.

If OK replace EG400.

7.6.4.4 Reduced gray scale

- Follow instructions in guide 7.6.4.1 to localize malfunctioning item. Replace components one by one and take 3D images of a suitable phantom.

7.6.4.5 Shadows on the projection image

- Redo collimator calibration and pixel calibration.

7.6.5 Panorama imaging

7.6.5.1 PAN sensor is not recognized

- Check that the sensor is attached properly to the X-ray unit and that the locking lever is in its lowest position.
- Check condition of the power feed by following the trouble shooting guide 7.6.3.5 for Panorama imaging not working.
- Bypass the installed LVDS data cable by using a separate jumper cable and connect it between R3210 and the PAN sensor (J3205 ⇔ ribbon connector). Reboot the X-ray unit.

If PAN sensor is recognized, replace one by one following components.

⇒ Original data cable between R3210 and EC100.

⇒ EC100.

⇒ R3210.

⇒ PAN sensor.

7.6.5.2 Image is messy

- Check condition of the power feed by following trouble shooting guide 7.6.3.5 for Panorama imaging not working.

7.6.5.3 Image is too dark or light

- If the CT-image is also dark then follow trouble shooting guide for the exposure control.

7.6.6 CEPH imaging

7.6.6.1 CEPH sensor is not recognized

- Follow the PAN trouble shooting.

7.6.6.2 Image is messy

- Follow the PAN trouble shooting.

7.6.6.3 Image is too dark or light

- Follow the PAN trouble shooting.

7.6.7 Exposure control

7.6.7.1 Exposure does not start when the exposure switch is pressed

- Check the condition of the power supply by following trouble shooting guide 7.6.3.8 for R3210 and R3300 does not operate.
- Set the X-ray unit to standby mode, press exposure switch and check the status of the X-RAY ENA LED (D5).

If D5 does not come on when the exposure switch is pressed, connect JG206 and shortcut pins 1 and 2 with a jumper.

⇒ If the LED still does not come on, replace EG200.

⇒ If the LED now comes on, replace the connector to JG206 and remove JA206 from EA200 and short circuit pins 1 and 2.

⇒⇒ If the LED does not come on, replace cable JA206 ⇔ JG206

⇒⇒ If the LED comes on, replace connector to JA206, remove JA207 from EA200 and short circuit pins 1 and 2.

⇒⇒⇒ If the LED does not come on, replace cable between EA200.

⇒⇒⇒ If the LED comes on, replace connector to JA207 and short circuit pins from J1003 (back of column)

⇒
If the LED does not come on, replace cable JA207-J1003.

⇒
If the LED comes on, replace external exposure switch.

If D5 does not come on when the exposure switch is pressed, connect JG206 and shortcut pins 1 and 2 with a jumper.

If LED D5 comes on, set the unit to imaging mode (CT or Pan), disable movements and then check status the of the PREH_ENA LED (D6).

⇒ If the LED D6 does not come on when exposure switch is pressed, check system-status, using the s2terminal, that the exposure switch is detected when it is pressed.

⇒⇒ If not, check the condition of the exposure switch, EA200, EA300 and the cabling between them.

⇒⇒⇒ If the components are OK, replace R3400.

⇒ If LED D6 does not come on, check the condition of the cable between J3202 and JG206.

⇒⇒ If the cable is OK, replace EG200.

⇒⇒ If not, replace cable.

⇒ If LED D6 comes on, the exposure switch is OK.

⇒⇒ Follow high voltage trouble shooting.

7.6.7.2 Exposure sequence starts but no X-rays are generated

- Check the condition of the power supply by following the trouble shooting guide 7.6.3.8 for R3210 and R3300.
- Set the unit to imaging mode (CT, Pan or CEPH), disable movements using command **nomove** (s2terminal) and check status of the PREH_ENA LED (D6).

If LED D6 does not come on, measure the voltage, JG206-6, during preheat.

⇒ Replace EG200 if the voltage is about 5V.

⇒ Measure voltage from J3202-6 during preheat.

⇒⇒ Replace cable between JG206 ⇔ J3202 if there is voltage on J3202.

⇒⇒ Replace R3210 if there is no voltage on the J3202.

If LED D6 comes on, check the EXP_ENA LED D7.

⇒ If LED D7 comes on, follow the trouble shooting guide for X-ray generation.

⇒ If LED D7 does not come on, measure the voltage during exposure from connector J3303 pin 5.

⇒⇒ If the voltage goes above 2V replace R3300.

⇒⇒ If voltage is near 0V then measure voltage at connector J3202 pin 7.

⇒⇒⇒ If voltage goes above 2V check and if faulty replace cable between J3303 and J3202.

⇒⇒⇒ If voltage is near 0V replace R3210.

7.6.8 X-ray generation

7.6.8.1 No X-rays generated

- Check condition of the power supply by following trouble shooting guide 7.6.2.3 for no X-rays.
- Check the condition of the exposure switch by following trouble shooting guide 7.6.7.2 for Exposure sequence starts but no X-rays.
- Set the X-ray unit to the imaging mode (CT or Pan), disable movements (s2terminal), press exposure switch and check the status of the Preheat LED (D3) on the R3800.

If LED D3 does not come on, check the condition of the cable between connectors J3314 and J3810.

⇒ If cable faulty replaced it.

⇒ If cable OK replace R3800.

If LED D3 comes on, check the status of the exposure LED (D31) on the R3800.

⇒ If LED D31 does not come on, check the condition of the cable between connectors JG214 and J3810.

⇒⇒ If cable faulty, replace it.

⇒⇒ If cable OK, check if the FAIL LED is on.

⇒⇒⇒ If not replace R3800.

⇒⇒⇒ If the FAIL LED comes on replace R3800. If the LED still comes on after replacing R3800, replace the tubehead.

7.6.8.2 Images too dark or too light (Wrong dose generated)

- Check the condition of the power supply by following trouble shooting guide 7.6.2.3 for no X-rays.
- Check that X-ray unit calibrations have been carried out.

Preheat check

- Set the X-ray unit to the 3D imaging mode (and using the s2terminal type patient), adjust the mA settings from the GUI and then measure the respective voltages from TP11 (Preheat reference).

If voltages differ from those listed below, replace EG200.

8 mA ⇔ 1.54V

10 mA ⇔ 1.59V

12.5 mA ⇔ 1.65V

15 mA ⇔ 1.70V

If the voltages do not differ, set the mA to 15 mA and measure voltage from TP15 (preheat feedback) when an exposure is taken.

⇒ if voltage is not 0.58V then replace R3800.

⇒⇒ If this does not solve the problem still, replace the tubehead.

mA check

- Set the X-ray unit to the 3D imaging mode (and using the s2terminal type **patient**), adjust the mA settings from the GUI and measure the respective voltages from TP11 (mA reference).

If the voltages differ from those listed below then replace EG200.

8 mA ⇔ 3.56V

10 mA ⇔ 3.19V

12.5 mA ⇔ 2.72V

15 mA ⇔ 2.26V

If the voltages do not differ, set the mA to 15 mA and measure voltage from TP13 (mA feedback) when the exposure switch is not pressed.

⇒ if voltage is not 5.0V replace R3800.

⇒ If voltage is near 5.0V take an exposure and measure the voltage again at the same TP13.

⇒⇒ If voltage is not 4.3V then replace R3800.

⇒⇒⇒ If this does not solve the problem still, replace the tubehead.

⇒⇒⇒ If voltage is near 4.3V, check the condition of the ribbon cable.

⇒
If faulty, replace it.

⇒
If the cable is OK, replace EG200.

kV check

- Select the following exposure parameters: standard resolution, 61x41 FOV, 16 mA, 90 kV and measure the voltage from TP8 (kV reference).

If voltage is not 0.92-0.93V remove the cable from J3807 and carry out the same measurement from cable pin 5 (pin16 is ground).

⇒ If voltage is 0.92-0.93V, replace R3800.

⇒ If voltage is not 0.92-0.93V check the condition of the cable.

⇒⇒ If the cable is faulty, replace it.

⇒⇒ If the cable is OK, replace EG200.

If voltage is near 0.92-0.93V, measure the voltage from TP7 (kV feedback from tube).

⇒ If voltage is 1.25-1.26V measure voltage from TP13 (mA feedback).

⇒⇒ If voltage is not 0.58V replace R3800.

⇒⇒⇒ If replacing R3800 does not solve the problem, replace the tubehead.

⇒⇒ If voltage is 0.58V check condition of the ribbon cable.

⇒⇒⇒ If faulty, replace it.

⇒⇒⇒ If the cable is OK, replace EG200.

7.6.9 Motion control

There are five possible types of malfunction:

- Mechanical malfunction
- Power supply problem
- Actuator malfunction
- Sensor malfunction or
- Control malfunction

Mechanical malfunctions are easy to identify because in most of cases they are clearly visible. For this reason they are out of the scope of this document.

In most cases it is good practice to check the condition of power supply first. The trouble shooting related to the power distribution is described in chapters 7.6.2 and 7.6.3. Basically checking whether the power supply indicator LEDs are on or off will indicate the condition of the power distribution.

Actuator malfunction can be caused either by a faulty motor or faulty driving electronics. Use the s2terminal, the **drivemotor** command, with suitable parameters, to check the status of the motors. If there is no motion the faulty component can be easily found by replacing them one by one, the motor, the driving electronics and then the cabling until the faulty component is identified.

Sensor malfunctions can be solved in same way as actuator malfunctions. Selecting service mode and then using the **systemstatus** command will show the status of most sensors (optosensor and micro switches). Trouble shoot by manually moving the unit and following the status changes for the sensor you wish to check. Alternatively start the **drivemotor** command in manual mode for example **drivemotor X man** will drive the X motor back and forth (when chin support up/down keys are pressed). If the status does not change when an opto or mechanical switch is activated, then changing the sensor or its related cabling should fix the problem.

If related cables and switches are found to be working, the problem is probably caused by a faulty logic board (R3210, R3300 and/or R3400). The related block diagrams give an overview of what components comprise a particular motion.

Note! *Some of sensor signals travel through the serial interface (J3213 ⇔ JG205). If such a signal is shown incorrectly, the fault may be in either the cabling, the sensor, or the serial interface board (EG200).*

7.6.10 Z-Motion control

7.6.10.1 Main support up/down (Z) movement does not work

- Check that the LEDs UP/DOWN and ENA on R4300 come on when the Z up/down buttons are pressed. If not, check that both direction and enable signals from the buttons are reaching the R3400 board by using service command **systemstatus**. Check the connection of the buttons and replace if needed.
- Check that the voltage selector on EA200 is set to the mains voltage being used.
- Check fuse 1 on R3400.

Replace if blown.

- Check that lamp (LA1) on R3400 is on.

If not, check J3411 & J3412 are connected.

⇒ If connected, check that the voltage between J3411 & J3412 is 230Vac.

⇒⇒ If NOT, replace voltage selector transformer.

⇒ If not connected reconnect J3411 & J3412.

If lamp LA1 is on replace R3400.

- If after replacing R3400 the movement still not work.

Check the motor connection at the top of the column.

Check the connection to, or replace the start capacitors at the top of column.

If replacing the start capacitors did not help, replace the lifting motor.

7.6.10.2 Main support movement only works in one direction

- Check that the support has not been driven to its highest or lowest position.
- Check the low voltage distribution by following the trouble shooting guide 7.6.3.8 for R3210, R300 or R3400.
- Check that the LEDs UP/DOWN and ENA come on when the Z up/down buttons are pressed.

If the LEDs do not come on, check that both direction and enable signals from the buttons are reaching the R3400 board by using service command **systemstatus**. Check the connection of the buttons and replace them if needed.

If the LEDS do not come on, but the direction and enable signal status' change in **systemstatus** when the buttons are pressed, the up/down limit switch detection is malfunctioning.

⇒ Check if D30 (lower limit) or D31 (upper limit) on the R3400 (under the EA300 board) is on.

⇒ Short circuit the pins connected to the upper limit switch or lower limit switch in J3417. If LED D30 or D31 is still on, replace R3400. Otherwise replace the limit switch and its cable.

If the LEDs are on then the motor control is working.

⇒ If the Z-motor makes a humming noise when attempting to drive it, replace R3400.

⇒ If no noise is heard, check the connection to, or replace the start capacitors at the top of column.

⇒ If replacing the start capacitors does not help, replace the lifting motor.

7.7 Calibration program numbers

Program number	Calibration
301	Panoramic collimator calibration
302	Panoramic geometry calibration
303	Panoramic pixel calibration
304	Panoramic still image
305	Panoramic test pattern
306	Panoramic QC
307	Panoramic positioning lights
316	Cephalometric collimator calibration
317	Cephalometric rotation angle cal.
318	Cephalometric rotator position cal.
319	Cephalometric detector calibration
320	Cephalometric QC
322	Cephalometric still image
323	Cephalometric positioning lights
332	3D detector position calibration
333	3D geometry calibration
334	3D collimator calibration
335	3D pixel calibration
336	3D QC
337	3D test pattern
338	3D positioning lights
339	3D High resolution geometry calibration
361	Positioning lights calibration
362	Preheat calibration
363	Tube mA current calibration

7.8 Imaging program numbers

Program number	Imaging
364	Standard panoramic
365	Pediatric panoramic
366	Ortho Zone
367	Orthogonal panoramic
368	Wide arch panoramic
369	Lateral TMJ
370	PA TMJ
371	Maxillary sinus
372	Bitewing
376	Pediatric lateral cephalometric projection
377	Lateral cephalometric projection
378	PA/AP cephalometric projection
379	Carpus projection
384	61 x 41 mm Standard Resolution
385	61 x 78 mm Standard Resolution
386	61 x 41 mm High Resolution
387	61 x 78 mm High Resolution
388	61 x 41 mm Scout
389	61 x 78 mm Scout
391	75 x 75 mm Standard Resolution
396	75 x 75 mm High Resolution

8 Maintenance procedure

In some countries it is mandatory to ensure the system image quality and consistency through regular quality controls. The dealer should provide the necessary instructions on how to do the QC according to the local regulations.

The maintenance procedure described below must be carried out at regular intervals in accordance with national regulations regarding the use and maintenance of x-ray devices that are in force in the country in which the unit is installed.

The calibrations mentioned in the user manual can be done by the user. Only qualified service personnel is allowed to do the calibrations mentioned in the installation manual.

In any event, the maintenance procedure must be carried out at least once a year. When taking measurements that require a multimeter, always use a calibrated digital multimeter (DMM).

Annual maintenance

1. Power on the unit and make it ready for exposure in the “Panoramic light” service program. Check that the rotator stays firmly in position. No noticeable slack shall be present in X, Y and N directions. For the rotational movement some minor slack can be allowed, as long as the movement centers itself to the same position after being pushed. If slack is encountered, check for loose parts and exchange worn out parts. Tighten the rotational movement belts if needed.
2. Power off the unit and disconnect it from the mains power supply.
3. Check the condition of the main power supply cable. Replace the cord if damaged.
4. Remove the tube head covers.
5. Check that the tubehead shows no signs of leaked oil. Replace the tubehead if it shows any signs of leakages.
6. Use a vacuum cleaner to remove dust accumulated in and around the air intake of the generator housing.
7. Check the safety ground continuity by measuring the resistance between the ground pin on the connector of the mains power supply cable and some metal part of the

unit. The resistance must be below 0.2 Ohm.

8. Reattach the covers and connect the unit the mains power supply.
9. Check that all covers are correctly installed and in good condition. Also check that all labels are attached to the init and that they are legible.
10. Perform a motor movements using the s2terminal service command “autotest”. Make sure the motors operated smoothly and without noise.
11. Perform all calibration and quality check programs.
12. Clear service indicator using s2terminal command “indicator”.

Motors and movement mechanisms

Perform a check of the motors and movement mechanisms before any covers are removed to survey the need for service.

Check the X, Y, N and rotational movements for slack by powering on the unit and making it ready for exposure in the panoramic light service program. The rotator shall stay fi rmly in position. No noticeable slack shall be present in X, Y and N directions. For the rotational movement some minor slack can be allowed, as long as the movement centers itself to the same position after being lightly pushed out of position. Tighten the rotational movement belts (2 pcs) if needed.

Perform a motorized movement test using s2terminal service command “motortest”. Check that all movements are done smoothly and without noise. If any problems are encountered, service the movement mechanism(s) as needed. Clean away dirt and apply new lubrication. Fasten loose parts and exchange worn out ones.

Mains power supply cable

Power off the unit and disconnect it from the mains power supply. Check the condition of the main power supply cable. Replace the cable if damaged.

Tubehead

Remove the covers around the tubehead. Make sure that no oil has leaked from the tubehead. Replace the tubehead if leakages are encountered.

Ground test

Test the safety ground continuity by measuring the resistance between the ground pin on the mains power supply cable connector and some metal part in the rotator. The resistance must be less than 0.2 Ohm.

Fan operation

Check that the fans in the generator housing air intake and outblow, as well as the the fan in the power supply air intake is operating normally and without noise. Clean the fans from dust if needed. Replace faulty fans.

Dust removal

The generator housing and the electronics contained therein must be free from dust to avoid risk of fire. Check the generator housing for accumulated dust and use a vacuum cleaner for dust removal if needed.

Labels

Check that all labels are attached and legible. A list of labels can be found in the Installation Manual, section 1.12 Unit identification labels.

Adjustment and calibration

Reattach upper and lower rotating unit covers before performing any calibrations. The movements might otherwise be obstructed or not behaving as during normal operation. After attaching the covers, power on the unit and perform a movement test (s2terminal service command “motortest”). Note that pixel calibrations shall be done with tubehead covers attached.

Covers

Check that all covers are correctly installed and in good condition.

Quality Assurance

Perform the Quality Check programs for all installed modalities. Ensure the results are acceptable.